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XIV.—*Observations on New Lichenicolous Micro-Fungi.* By W. Lauder Lindsay, M.D., F.L.S., &c. (Plates XXIII.–XXIV.)

(Read 19th April 1869.)

In the course of my studies on the Microscopic Anatomy of Lichens, during the last fifteen years, I have frequently met with various more or less minute *Parasites*—mostly black and punctiform or papillæform—sometimes disciform or maculæform—affecting either the thallus or apothecia of lichens, or both thallus and apothecia. They grow equally on foliaceous and crustaceous lichens, especially of the following genera:—*Parmelia; Physcia; Umbilicaria; Solorina; Peltidea; Nephromium; Sticta; Stereocaulon; Usnea; Neuropogon; Cladonia; Bæomyces; Squamaria; Placodium; Lecanora; Pertusaria; Thelotrema; Lecidea; Graphis; Endocarpon; Verrucaria.*

Most of these Parasites occur on lichens in my own Herbarium, collected by myself in 1856; or on lichens sent me for examination and determination by various British lichenologists between 1856 and 1858. They were examined, and described with figures in my Herbarium Note-books, between 1856 and 1859; in most cases without the assignation of *names*. I have not hitherto published their descriptions, or assigned names, for a variety of reasons, and especially on account of the difficulties which appear to me* to surround the determination of what, to any single observer, seem to be (so-called) "new species." Hence the parasites in question have been accumulating in my Herbarium, and their descriptions in my Note-books, for twelve years or upwards; and they now form a large and interesting, though obscure and puzzling, group of microscopic plants. I cannot, however, quote them in a Memoir I have in preparation on the Spermogonia and Pycnidia of the lower lichens (with which Spermogonia and Pycnidia the said parasites are frequently apt to be confounded) without placing their description—and, in certain cases at least, their names—on record in a form convenient for future reference. Nor can I otherwise contrast with them various groups of Lichenicolous Micro-Lichens,† Micro-Fungi, or Micro-Algæ, which have been described by other authors, or having been observed are yet to be described by myself. Inasmuch, moreover, as the said descriptions and names have not been, so far as I am aware, published by other authors—whether fungologists or

* *Vide* Author's "Contributions to New Zealand Botany," 1868, p. 22; "Otago Lichens and Fungi," Transactions of Royal Society of Edinburgh, vol. xxiv. p. 407; "Parasitic (lichenicolous) Micro-Lichens," Quart. Jour. of Micro. Science, January 1869; "Polymorphism in Fructification of Lichens," Quart. Jour. of Micro. Science, January 1868.

† *E.g.* "Enumeration of Micro-Lichens parasitic on other Lichens," Quart. Jour. of Micro. Science, January 1869.

lichenologists—I can no longer hesitate in contributing to botanical science the following observations on the structure and place in classification of the Micro-Parasites referred to.

In the earlier years of my lichenological studies, I examined microscopically, with the greatest minuteness, large numbers of lichens for different collectors, from various parts of Britain and Ireland. I gave much more attention to the contents of other Herbaria than to those of my own; and to this circumstance, along with my reluctance to describe and name "new species"—a hesitancy to "rush into print" with accounts of mere novelties, real or supposed—I owe the fact that many of my own gatherings in different parts of the world—many of the original observations recorded in my MSS.—have been published to science, with the stamp and *éclat* of novelty, by other—mostly continental—lichenologists. This, however, I do not regard as subject for regret. Much more important than the mere discovery and nomenclature of so-called "new species"—only a small proportion of which has any claim to *permanent* rank as *species*—is, I think, the proper classification of existing material, so as to render additions to our knowledge capable at once of estimation at their proper value, and of absorption and assimilation in their proper place. So far as regards descriptive or systematic lichenology, my own aim has always been and still is to arrange on a *simple* plan of classification the data already accumulated, so that they may be readily accessible and intelligible to the student. My own studies in lichenology are and have been preferentially biological; regarding as I do questions affecting (*e.g.*) the physiology and anatomy, affinities and uses, of lichens as of higher interest than the *mere collection and nomenclature of varieties or species!*

The lichenicolous parasites above-mentioned are partly of the character of true *lichens*, partly of true *fungi;* while many partake of, or possess, the characters both of lichens and fungi, and can be appropriately referred only to the intermediate group of *fungo-lichens*.* In the present communication I confine myself to the two last-named groups—to Parasites which are either true *fungi* or *fungo-lichens*. All of them require for proper examination the microscope, and most of them are distinguishable only under the lens. Very few, such as *Coniothecium* sometimes, are sufficiently large to be visible to the naked eye. All are rendered more conspicuous by moisture, which frequently converts punctiform into papillæform perithecia, and flat surfaces into convex ones.

In determining the *genera* under which to arrange the parasites hereinafter to be described, I have availed myself of the opinion, kindly accorded, of two of the most competent British Fungologists, who have at various times examined certain of the said parasites at my request, viz., Rev. M. J. Berkeley, F.L.S., and Fred. Currey, F.R.S. While agreeing with these distinguished fungologists

* *Vide* Author's "Otago Lichens and Fungi," p. 434, and *Arthonia melaspermella*, Journal of Linnean Society (Botany), vol. ix. p. 269.

in many, I do not profess to agree with them in all, respects. When they claim parasites as indubitable *fungi*, I have no hesitation in accepting their determinations, as I have done (*e.g.*) in the case of various organisms referred by Mr CURREY to *Torula*, *Coniothecium*, and *Sphæria*. While agreeing with Mr BERKELEY as to the close alliance between the fungi and lichens,* I cannot subscribe to his views of the place in classification to be assigned to various members of the group of *fungo-lichens*.†

Many of the lichenicolous parasites hereinafter described belong to the *Torulacei*—to the genera *Torula* and *Coniothecium*. The majority of the remainder, which are confessedly most heterogeneous, I arrange provisionally under the genus *Microthelia*, adopting this genus only in the sense elsewhere and already explained.‡ The parasites in question are, in a manner at least, hereinafter systematically described in detail, their variations especially being made the subject of exposition. But *here* it is desirable to make certain preliminary *general* observations regarding the more prominent of their features

1. GENUS *Torula*.§

What I hereinafter describe as *T. lichenicola* varies considerably in its internal characters. In particular the spores are not always simple. Nevertheless all the forms described appear to me to be referable to a single type or species. Externally, *T. lichenicola* shows little diversity of form. It is black, punctiform, and superficial, resembling in this respect, and apt to be confounded with,

(*a*). *Spermogonia* and
(*b*). *Pycnidia* } of many lichens, especially when intermixed therewith.

(*c*). Many minute parasitic *lichens* belonging to such genera as *Verrucaria* and *Endoccocus*.‖

(*d*). Many minute parasitic *fungo-lichens* belonging to the provisional genus *Microthelia*.

* In various letters Mr BERKELEY has expressed himself as follows:—"So convinced am I of the near relation of lichens and fungi that in the portion of my 'Introduction to Cryptogamic Botany,' which is printed, I make one division, *Mycetales*, to include *Fungales* and *Lichenales*" (July 1856). . . . "One or two *Verrucariæ* are so near *Sphæriæ* that it is almost impossible to draw the line" (Dec. 1856). . . . "It is quite impossible to distinguish some *lichens* from *fungi*, and I consider the whole series as a division of *fungals*" (Feb. 1869). I hold quite as decided an opinion as to the *impossibility of distinguishing many lichens from many fungi;* or, in other words, of referring members of the group of *fungo-lichens* to the group of *fungi* rather than to the *lichens!* But I regard any classification, which arranges *lichens* as a co-division with *fungi* of a group of *fungals*, as imperfect, artificial, and arbitrary, excluding as it does the equally close alliance that subsists between lichens and *Algæ*.

† His views and my objections are fully given in a subsequent part of the present memoir (pp. 528–580).

‡ "Otago Lich. and Fungi," p. 436; *Arthonia melaspermella*, p. 279.

§ As determined by Mr CURREY, who wrote me in February 1866 as to "a curious species of *Torula*" (contained in my Herbarium) "which I do not recognise as having seen before. It is ramose, with bluish or greenish-black joints, the cells of which measure from 0·0003 to 0 0005 inch."

‖ *E.g.* those described in KÖRBER's "Parerga," p. 452, *et seq.*

(*e*). Many minute parasitic *fungi*, belonging especially to the genus *Sphæria*.
(*f*). Certain members of the pseudo-genus (of lichens) *Pyrenothea*.
(*g*). Granules of coal dust, or other inorganic foreign bodies.

From all of these the *Torula* is readily distinguished on microscopical examination, more especially by the presence of its peculiar spore-chains or filaments. There is no complete perithecium; but the basal cellular tissue, from which spring the spore-filaments, and which is generally sub-immersed in the host, is indistinguishable from that which constitutes the envelope or perithecium in many lichens, fungi,* or fungo-lichens, and their spermogonia or pycnidia. The cellular tissue in question is most frequently of an indigo colour, or bluish or bluish-black, though sometimes also it is brownish; not varying, however, in colour to so great an extent as do the spores. The free surface, which is granular or powdery, consists of spores separated from their filaments, and of the apices of the spore-filaments, which are closely aggregated, just as are the sterigmata or basidia in lichen or fungus-spermogonia, and pycnidia. In the young state, these filaments are simple hyaline tubes, resembling the simple paraphyses of many lichens, broader or thicker at the distal or free end, tapering into a thread-like pedicle at the lower, basal or proximal extremity. Gradually, however, articulations appear, beginning first at the distal end; and colour is added, the filament increasing in volume. The filaments then resemble the articulated paraphyses of many lichens, *e.g.*, *Lecidea lenticularis*, Fr. Usually in maturity four or six articulations are formed, and gradually thrown off one after another from the distal end as free spores. Sometimes only one or two articulations are developed. The spore-filaments necessarily vary considerably in length, but less so in breadth. Some filaments appear to be abortive, and maintain throughout the simple or non-articulated, colourless character; not even increasing in length. These sterile filaments are intermixed with the fertile ones—just as sterile sterigmata—in this case generally elongated and ramose, and exceptionally articulated or pseudo-articulated, frequently accompany the fertile ones in the spermogonia of many lichens.† Occasionally there is atrophy of certain articulations, which then assume the character of threads connecting the normal spores. The distal half of the spore-filament is generally coloured, though the colour is sometimes faint or exceptionally absent. Where colour exists, it is always deepest at the distal or free end—in the terminal articulation. This colour is most frequently bluish (indigo or with a blackish shade); but sometimes it consists of various shades of olive or brown. The colour of the spore-filament is that also of the articulations of which it is composed. The colour of the spores is much more variable than their

* E.g. *Dichæna rugosa*, Fr.

† *Vide* author's "Memoir on Spermogones and Pycnides," Trans. Royal Society of Edinburgh, vol. xxii. plates iv. v. vi. vii. viii. xi. xii.

dimensions or form. The proximal articulation is frequently colourless, while the terminal one is deeply coloured. In size the articulations always vary on the same filament—the oldest or terminal one being the largest—the younger being at least narrower in proportion to their youth. Thus the terminal spore is frequently twice as large as the proximal one, the increase in dimension relating to breadth rather than length. In maturity, and when free—thrown off from their filaments—there is much less difference in the form and size of the spores. In form they are generally oblong, with flattened ends, unless in the terminal spore, which has its free or upper end rounded, even while attached to the filament. Occasionally the corners of all the free articulations or spores are similarly rounded. Sometimes the spores are oval or ellipsoid. Their length is generally about ·00025″. In structure they are usually simple, with or without double contour; sometimes, though rarely, granular; occasionally also having a central septum, or faint indications of the existence of one or more septa; more frequently containing one or more (two to three) spherical nuclei. Where there are two nuclei, they are generally arranged near the poles or extremities of the spores, to which they sometimes then give a sub-physcioid aspect, that which occupies the distal end of a spore being always the larger. This bi-nuclear character may attach to all the spores in a given specimen; and then, as well as in other cases, the spores in question resemble many lichen-sporidia. Sometimes chains or groups of spores of equal size and uniform character occur in numbers of four to eight, apparently the result of agglutination after maturity, and gaining the free state. In some cases the concatenate condition might be supposed to arise from simple absorption or disappearance of the pedicle of the filament; but in such a case the constituent articulations would probably retain, even in age, their differences in size. The *site* of *Torula lichenicola* is the thallus or apothecia (or both) of various lichens, mostly crustaceous, and belonging to the *Lecanoræ* or *Lecideæ*. It is much more common in *Lecanora subfusca* than in any other species in my own experience; and it is so markedly more common on *Irish* specimens of that *Lecanora*—mostly from the vicinity of Cork—as to give rise to the supposition that there may be some connection between the greater frequency of the parasite in Ireland and the (alleged) greater moistness of the climate of that country. There is, moreover, a frequent connection between the growth of the parasite and degeneration of the thallus or apothecia of the host; sometimes at least, obviously as productive of degeneration, *e.g.*, when the *Torula* overspreads the disk of *L. subfusca*, rendering it as black as that of *L. atra* On the thallus of lichens it may be scattered generally over the surface; or only over particular parts thereof, *e.g.*, the periphery, or it may occupy only the areolæ or verrucæ. On the apothecia it may occur only on the disk, or both on the exciple and disk. The apothecia affected by the parasite are frequently degenerate or deformed; the disk has sometimes disappeared, and the whole apothecium has acquired an irregularly

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verrucæform character. But in this case the degeneration appears to be quite unconnected with the growth of the parasite, which equally affects the thallus and apothecia, whether healthy or diseased, normal or deformed. The parasite may be scattered; or closely aggregated, becoming confluent and maculæform; or it may be copiously studded over the apothecia, and sparingly on the thallus of the same species, or *vice versa*, though the former arrangement is the more common. Generally there is a marked contrast of colour between the parasite and the whitish or greyish thallus, brownish or reddish disk of the apothecia, which it so frequently affects. Necessarily the *Torula* is most conspicuous by reason of this contrast, where the thallus and disk of the host are pale—whitish in the one case, and brownish in the other. Its structure is essentially the same on whatever lichen it be parasitic. In one case I found it occupying the cavity of spermogonia (in *Lecanora varia*).*

2. Genus *Coniothecium*.

There are various points of resemblance between *Coniothecium lichenicolum* and *Torula lichenicola*. In both cases the parasite is black, and is conspicuous from contrast of its colour to that of the pale (or whitish) thallus on which it so frequently occurs. In the *Coniothecium* the basal cellular tissue is the same. There is no complete perithecium; the granular or powdery surface consists of the free spores, which possess deep and dirty colours, mostly brown, though sometimes blackish or olive. In the young state only is the *Coniothecium* papillæform or verrucarioid, in which condition it may be confounded externally with *Torula*, or with the various organisms with which the *Torula* may itself be confounded. But there is a greater number of points of difference between these two common lichenicolous parasites. While *Torula* mostly affects *corticolous* lichens in the *fertile* state, *Coniothecium* affects only *saxicolous Lecanoræ* in the *sterile*, and frequently isidioid or other degenerate or hypertrophic, condition. In maturity, moreover, *Coniothecium* is much larger, and more conspicuous—visible for the most part to the naked eye. It is largish and flattish, discoid or lecidioid, resembling some forms of the pseudo-genus (of lichens) *Spiloma*, as well as the parasitic Spilomatic fungi—*Spilomium Graphideorum*, and *Gassicurtia silacea*. It varies considerably in size, surface, and outline; in the old state frequently resembling soot-spots. It is apt to be confounded with the apothecia, especially when they are sub-degenerate, of various saxicolous *Lecideæ;* and the character of the spores is sometimes such as to assist in this confusion. These spores are typically, in the young state, spherical and single; but they gradually acquire a sub-cubical form, and are associated in groups—sometimes most irregular in outline—of two, three, or four, the form of the constituent spores then undergoing

* *Vide* p. 520, and foot note †.

change from mutual pressure. Their colour is usually in maturity and age a deep blackish-brown; but in the young state they may be pale, or even colourless; while in older conditions they may be olive, with a blackish tinge. When aggregated in groups of two, if the form of the constituent spores remains comparatively regular, they may be indistinguishable from some figure-8-shaped lichen or fungus-sporidia. Hence, in one case, among the parasites hereinafter described (the Mangerton plant),* it is difficult to determine whether it is *Coniothecium lichenicolum* or a separate parasite. Sometimes the spores are concatenate, as in *Torula;* but they are at once distinguished from those of *Torula* by their breadth being greater than their length, as well as by their sub-cubical form. When in aggregates of four, the spore-groups resemble wool-pack-like or *Sarcina*-like cubes. When in threes, as well as sometimes in twos or fours, they are very unlike spores, and are apt to be mistaken for fragments of cellular tissue, such as that which constitutes the perithecium of many of the lower lichens and fungi.† Whether simple or aggregate, the spores always exhibit double contour, presenting the aspect of being thick-walled. The *Coniothecium* may be scattered, as it generally is, or grouped; very rarely it is closely aggregated or even confluent. The thallus, which it affects, is frequently so altered—apart, however, from the growth of the parasite—that, in the absence of apothecia, it is impossible to determine the *species* to which it is referable. It appears generally, if not always, to belong to *Lecanora*, and, at least frequently, to the species *tartarea*, *parella*, and *glaucoma*.

3. Genus *Microthelia*.

The parasites, which I have provisionally grouped in this pseudo-genus,‡ are confessedly most diverse in character, though they possess certain characters in common. For the reasons elsewhere set forth,§ I think there is an advantage in considering them *as a group* until their characters are more fully known and understood. Their common or general characters are the following:—

Most of them are microscopic, like *Torula;* black, papillæform or punctiform. The papillæform or verrucarioid condition is always rendered more distinct by moisture. Sometimes they are flattened and discoid, lecidioid or arthonioid (*e.g.*, the parasites on *Lichen dactylinus*, *Lecidea pachycarpa*, and *L. albo-atra*). Sometimes they are maculæform *ab initio* (*e.g.*, the parasites affecting *Squamaria crassa* and *S. saxicola*); at other times the maculæ are produced by the confluence or aggregation of minute papillæ (as in the parasite affecting *Parmelia perlata*).

* (*b*) P. 540.

† I have seen true *Lichen-sporidia* by cohesion acquiring characters closely resembling those concatenate and woolpack-like forms of the spores of *Coniothecium lichenicolum* (pl. xxiii. fig. 28), *e.g.*, in *Lecidea dubia*, T. and B., Leight. Exs. No. 88. In several other cases, I have met with Lichen-sporidia cohering in such manner as to resemble cellular tissue, *e.g.*, in *Verrucaria subalbicans*, Leight. Exs. No. 200.

‡ *Vide* p. 515, and foot note ‡.

§ "Otago Lich. and Fungi," p. 436.

Their size varies in the same species, but mostly with age. As to site, they affect the thallus or apothecia, or both; sometimes the under as well as upper surface of the apothecia. They are, like *Torula*, more frequent on fertile than sterile lichens. As in *Torula* and *Coniothecium*, they are conspicuous where the colour of their host is pale. As in these parasites also, they may be few or numerous, scattered or aggregated, discrete or confluent; in the latter case becoming maculæform. Externally, they frequently resemble *Torula* and *Coniothecium*, or the organisms with which they are apt to be confounded; as well as certain young lichen-apothecia, belonging to the *Lecideæ*, *e.g.*, *Abrothallus Smithii* and *oxysporus*. Generally only the base is immersed in the host, but sometimes the body of the perithecium is immersed, only the apex or ostiole projecting above, or being visible on, the surface of the host. The envelope or perithecium is in all cases the same, consisting of brown cellular tissue; frequently, if not generally, the cells being sub-hexagonal. The *Microthelieæ* are sometimes associated with, if not productive of, deformities or degenerations of the thallus or apothecia of the lichens on which they grow (*e.g.*, *M. Stereocaulicola*, *M. Bæomycearia*, and the parasite which affects *Squamaria saxicola* as *Torula* does *Lecanora subfusca*).

Their internal structure varies considerably. Some of them are verrucarioid, in so far as they possess sporidiiferous asci, with or without paraphyses. Where paraphyses exist, they are either very delicate, filiform, more or less indistinct, without thickened or coloured tips; or they appear as a mere striated jelly. The asci are frequently saccate, as in *Arthonia;* short and broad, not tapering below into a pedicle.

In another group, no asci, paraphyses, sterigmata, nor basidia, were visible, so that it was impossible to determine whether the contained reproductive corpuscles are to be considered sporidia, spores, stylospores, or conidio-spores. Probably in the majority of cases they are really sporidia contained in asci.

In a third series, the perithecia are quite sterile, containing no reproductive structure. Some of these parasites may prove to be mere pycnidia analogous to *Phoma*, *Septoria*, *Diplodia*, and *Sphæropsis*. At least one of the parasites grouped under *Microthelia* possesses *pycnidia* in addition to sporidiiferous perithecia, viz., that affecting *Thelotrema lepadinum*.

In certain exceptional cases, the same perithecium contained not only sporidiiferous asci, but stylospores and basidia; and in one instance ramose filaments, resembling the hypertrophied sterigmata of many lichen-spermogonia* (*e.g.* the parasites accompanying *Verrucaria epidermidis* v. *analepta*, and *Lecanora pyracea*). Parallel phenomena are the occurrence of sporidia and spermatia in the same perithecia in *Verrucaria atomaria* and *Sphæria Lindsayana*, as seen by myself, and in a certain section of the *Verrucariæ* as described

* *Vide* p. 516, and foot note †.

by GIBELLI.* This observation is one obviously of much interest in regard to the physiology of reproduction, and of the reproductive organs, in lichens. I doubt not that careful observation will yet multiply the number of instances in which *different forms of reproductive corpuscles exist in the same perithecium* or organ.

It may be provisionally convenient to classify the parasites grouped under *Microthelia*, according to the character of their contained reproductive corpuscles, as follows (omitting any specific mention of those whose reproductive structure is imperfect, and which are, therefore, for the present indeterminable):—

Sporidia, or reproductive corpuscles—

1. *Simple.* For the most part *spherical* and *brown.*

Microthelia atricola.
Spilomium Graphideorum.
Gassicurtia silacea.
Parasites on
(*a.*) Lecidea rupestris.
(*b.*) L. sanguinaria v. affinis.
Parasites on (*c.*) Graphis scripta.
(*d.*) Pertusaria.
Parasites accompanying
(*a.*) Opegrapha atra.
(*b.*) Abrothallus Smithii.
(*c.*) Pyrenothea verrucosa.

2. 1-*septate* (=bilocular).

A. *Brown*, in maturity; frequently or generally *soleaform.*

Microthelia Stereocaulicola.
rugulosaria.
Stictaria.
parietinaria.
Parasites on
(*a.*) Lecidea pachycarpa.
(*b.*) Thelotrema lepadinum.
Parasites on
(*c.*) Squamaria crassa.
(*d.*) Endocarpon microsticticum.
(*e.*) Usnea barbata v. florida.
(*f.*) Lecanora pyracea.
Parasite accompanying
Verrucaria fusiformis.

B. *Colourless* or yellowish; sometimes *simple.*

Microthelia Cookei.
Parasites on
(*a.*) Lecanora cenisia; brownish-yellow.
(*b.*) L. polytropa v. intricata; sometimes simple; colourless or yellowish.
Parasites on
(*c.*) Lecidea Hookeri; colourless.
(*d.*) Verrucaria Garovaglii; colourless.
Parasites accompanying
Verrucaria epidermidis v. analepta; colourless.

* So long ago as July 1856, Mr BERKELEY wrote me—"You are aware, probably, that in a species of *Tympanis*, Mr BROOME and myself have seen *on the same hymenium* the *spores* of a *Diplodia* and true *asci*. TULASNE doubts Mr BROOME and myself having seen *stylospores* on the *paraphyses* of a *lichen*. Nothing, however, was more clear and free from illusion. Almost in the same breath TULASNE calls in question the correctness of HOOKER and BABINGTON's observation. He should not do this. I sent TULASNE the very section we had seen the stylospores of the lichen in, but he could see nothing. Unfortunately, there were but two or three scattered apothecia on the roots of *Ammophila*, sent for a fungus by GARDINER. I have in vain tried to get more from the same locality." (*Vide* also my "Monogr. *Abrothallus*," p. 55; NYLANDER's "Prodromus," p. 55; BERKELEY's "Brit. Fungology," p. 87, plate i. fig. 13.)

In December of the same year Mr BERKELEY again wrote me (in regard probably to *Abrothallus Smithii*)—"In American specimens of your plant I sometimes find *asci*, sometimes *naked spores*, which have the same relation to the asci that the stylospores of *Diplodia* to the asci of the *Sphæria* to which they belong. Whether the production in question is a *lichen* or *fungus* is a knotty point. It grows on *living bark*, and therefore should be a *lichen!*"

3. 1 to 3-*septate*, mostly 3-septate and *brown;* sometime colourless.

Microthelia vesicularia; 1–3 septate.	Parasites on
Umbilicaria; 1- sometimes 2-septate.	(*a.*) Physcia ciliaris.
Nepromiaria; colourless.	(*b.*) Lecidea lurida.
Bacomycearia.	Parasites accompanying
	(*a.*) Lecidea ferruginea v. sinapisperma.
	(*b.*) Verrucaria Taylori.

Any such classification, however, is obviously artificial and defective; for not only in the same species, but in the same individual, the sporidia frequently vary much in character—in size, form, colour, and structure. In particular, they are frequently both simple and compound, colourless or coloured, of regular or irregular outline—according to the stage of growth. The "character" selected as the basis of classification must, therefore, be that which is presumed to prevail in maturity, and in normal conditions of growth. But what is prevalent or normal in one district or set of circumstances is not so in another, especially if the district or circumstances in or under which one systematist works are very diverse from those of others. There is, therefore, in such cases no precise or permanent basis of classification; whence it follows that the classification itself must be faulty. These remarks apply to too many modern "classifications" of lichens, based on the characters of the sporidia alone, or on any single "characters" or combination thereof!

In the group of parasites hereinafter described under *Microthelia*, the *Iodine-reaction*, which by fungologists is considered *lichenoid*, denoting the presence of *lichenine* in the lichen-tissues, is generally absent. In the parasite accompanying *Verrucaria epidermidis* v. *analepta*, however, the asci give a *blue* reaction with iodine; in *Microthelia Stictaria* they become deep *violet;* in *M. Umbilicariæ* the asci and hymenial gelatine assume various shades of violet; while in *M. Nephromiaria* the hymenial gelatine becomes violet. These exceptional reactions, however, neither prove nor disprove in themselves that the parasites, in which they occur, are *lichens* or *fungi;* for, as I have elsewhere* sufficiently shown, this so-called lichenoid reaction occurs in indubitable *fungi;* while there are many true *lichens* destitute of any colour-reaction—indicative of the presence of starch, or its varieties or allies—with iodine.

Iodine-reaction is a subject of so great (supposed) importance in relation to the differential diagnosis between lichens and fungi: and as a "character" it bears so intimately on the place in classification to be assigned to the group of fungo-lichens, and to the members of the provisional genus *Microthelia*, as adopted or established by me, that it requires here some additional consideration. As a ground for regarding it as a diagnostic "character," it appears to me necessary,

* *Arthonia melaspermella*, p. 283; "Otago Lich. and Fungi," p. 423; "Parasitic Micro-lichens."

in the first place, that we should possess some trustworthy information as to the *chemistry* of the reaction, and as to the nature of those substances which, in lichens and fungi respectively, yield colour-reactions with iodine. As regards the lichens, I have carefully studied the most recent and approved standard works in chemistry; and the result is, that I find a discrepancy and confusion of assertion and opinion among chemists, nearly as great as that which exists between lichenologists and fungologists in regard to the application of the test, or of its colour-reaction, as a botanical "character."

So far as I have been able to ascertain, the substances occurring in lichens, which give colour-reactions with iodine, of the class which is now under review, are the following:—

I. *Starch* or its modifications.

A. *Lichenine*, Syn. Lichen starch, Lichenic acid. *Formulæ*, $C_6H_{10}O_5$, $C_{12}H_{10}O_{10}$ (Gregory).* Has been examined by chemists as it occurs in *Cetraria Islandica* and *aculeata*, *Sticta pulmonaria*, *Ramalina fraxinea*, *Usnea barbata*, *Physcia parietina*.

Chemical characters.—Isomeric with starch. In *C. Islandica* does not occur in granules; but is uniformly distributed through the tissues in a soluble condition. *Pure* lichenine is merely coloured *yellow* by iodine; but a green or blue is often produced *from admixture of starch* (Watt).† A colourles jelly "sometimes assumes a *blue*, and sometimes a greenish tint," with iodine (Gorup Besanez).‡ Gives with iodine a greenish-*brown* colour (Kane).§ "Its solution is *not coloured* by iodine; but the jelly is rendered blue by that test" (Gregory). Other authors describe the reaction with iodine as *blue*, and this is the reaction (generally) assumed by lichenologists as the basis of their Iodine-testings.

B. *Inuline*, Syn. Dahline, Alantine, Menyanthine, Datiscine‖ (Gregory). *Formulæ*, $C_{12}H_{10}O_{10}$ (Gregory), $C_{24}H_{21}O_{21}$ (Parnell). Has been examined as it occurs in *Cetraria Islandica* in association with lichenine.

Chemical Characters.—Also isomeric with starch. Occurs in white, crystalline grains. Sparingly soluble in cold, very soluble in hot, water. Iodine colours it slightly *brown* (Gregory). Insoluble in alcohol. Not blue, but *yellow*, with iodine (Miller).

C. *Starch*. *Formula*, $C_{12}H_{10}O_{10}$. Has been examined as it occurs in *Ramalina fastigiata* (in large quantity); and *Cladonia macilenta*, *digitata*, and *uncialis* (Watt). It does not quite clearly appear whether this is ordinary starch in its

* "Handbook of Organic Chemistry," 4th edition (1856).
† "Dictionary of Chemistry," 5 vols. (1860–68).
‡ Quoted in "Chambers's Encyclopædia," 10 vols. (1860–68).
§ "Elements of Chemistry," 2d. ed. (1849).
‖ Miller ("Elements of Chemistry," 2d ed., 1862, p. 597") gives Datiscine ($=C_{42}H_{22}O_{24}$), as the *colorific* principle of *Datisca cannabina*—*not as a starch!*

ordinary form. There *is* a substance in lichens that gives a beautiful and deep *blue* reaction with iodine; and if chemists are correct in asserting that such a reaction is indicative of the presence of free starch in its ordinary form, while lichenine and inuline give yellow or brown colours to the reagent, we must admit that *common starch* not only occurs in the lichen-tissues, but that it is sometimes associated with, and at other times substituted for, lichenine and inuline.

II. *Gum*, or its modifications.

Gum has been examined as it exists in *Lecanora parella*. Gives a greenish-*blue* with iodine (SCHUNCK). Ordinary gum (= Arabin) is *not* altered in colour by iodine; but the modification thereof known as *Bassorin* gives *blue* and *red* reactions (MILLER, p. 109).

Were we to accept as a trustworthy basis for our conclusions the foregoing assertions of chemists, we would deduce that in lichens occur several forms or modifications of starch and gum that give reactions with iodine, variously blue, red, or brown, or admixtures of these shades, especially green. But it is impossible to accept as proper bases, on which to found *diagnostic* characters, statements so contradictory. The conclusion to be drawn is rather that chemists are yet ignorant in great measure of the composition and character of the mucilaginous and other components of lichens; and that at present they probably confound substances of somewhat dissimilar character. Thus the character of the iodine-reaction leads to the suspicion that what SCHUNCK describes as a *gum*, may be in reality a *starch!*

It by no means follows that the same reagent should produce the same colour-reaction in the same species of lichen, whether it is applied by the chemist in the laboratory to the separated amylaceous or mucilaginous principles, or by the lichenologist in his library to microscopical sections or preparations of the hymenium or other tissues. On the contrary, what we know of other colour-developments in lichens would lead us here to expect a certain difference in result; and, in point of fact, there *is* such a difference. And, further, differences of result in the same species, when iodine is applied as a test in microscopico-botanical diagnosis, arise in the hands of different experimenters from circumstances sometimes apparently most trivial, *e.g.*, the strength or character of the iodine solution, the age or other conditions of development of the specimen operated on. I need not, however, further pursue or illustrate the subject here, having pointed out in detail elsewhere the sources of fallacy and the causes of difference in the colour-reactions of lichens as supposed botanical characters.*

The substances or tissues in lichens, which yield colour-reactions with iodine, are chiefly—(1.) The hymenial gelatine or mucilage, which has hitherto been

* "On Chemical Reaction as a Specific Character in Lichens," Journ. of Linn. Soc. vol. xi. (Botany), p. 36; and "Experiments on Colour-reaction as a Specific Character in Lichens," Trans. Botanical Society of Edinburgh, vol. x.

generally assumed to be, but on insufficient grounds, lichenine; (2.) The asci; (3.) The sporidia; (4.) The medullary or other tissues of the thallus. Exceptionally colour-reaction may occur in other tissues. I have, for instance, met with a blue reaction from iodine in the interior structure of the *spermogonia* of *Abrothallus oxysporus* (Birnam, June 1856). The commonest iodine-reaction, that with which lichenologists have to do as a botanical character, is that of the *hymenial gelatine*,* in which are imbedded the asci and paraphyses; and of the *asci* themselves, on which the reaction is generally the most intense. *Typically* this reaction is a beautiful *Prussian-blue*; that is to say, it has been generally regarded by continental lichenologists as what NYLANDER calls a "Nota lichenosa,"—a diagnostic "character" of *lichens* as contra-distinguished from *fungi*. But this blue is not always exhibited in different specimens of the same species, nor even in the same specimen at different times; it may, moreover, be faint† or fugacious. In a large number of lichens, instead of blue, the colour-reaction with iodine is *violet*, *red*, *brown*, or *yellow*; while in another large group there is *no colour-reaction!* Thus, in the genus *Verrucaria*, as defined by NYLANDER (in his "Lich. Scand." p. 266), iodine developes in the hymenial gelatine of

(*a*.) One section—the supposed typical or lichenic reaction.
(*b*.) In another section—a wine red.
(*c*.) In a third section—a faint bluish or reddish tinge.
(*d*.) In a fourth section—no reaction.‡

To which it may be here added, that some *Verrucariæ* have no paraphyses, while in others they are distinct; but are always (where they exist) more or less graceful, delicate, and filiform. Further, different tissue-constituents of the same lichen, or different parts of the same organ, give frequently different colour-results with the same reagent.

These irregularities in colour-reaction may be conveniently and sufficiently illustrated by the following selection of quotations from the record of my microscopical examination of the lichens contained in the published Fasciculi of SCHÆRER (Switzerland), NYLANDER (France), and LEIGHTON (England). The advantage of using published Fasciculi is, that a standard of comparison is secured accessible

* The term, "gelatine" or "mucilage," is here used, and by lichenologists generally, in a popular, *not in a strictly chemical*, sense; for it has already been shown that the so-called "gelatine" may really be a form of *starch* or *gum*, or a mixture of forms of either or both! Compare *Arthonia melaspermella*, p. 283.

† It is faint or obscure in the following, and in many other, true lichens:—
Collema turgidum, Schær. Exs. 433. Asci.
Stereocaulon condensatum, Schær. Exs. 509. Asci.
Calicium stigonellum, Leight. Exs. 226. Asci.
Lecidea Wahlenbergiana v. *truncigena*, Ach., Leight. Exs. 123. Hymenium, mere trace.

‡ In his "Prodromus" he describes some species as possessing a yellow reaction, *e.g. V. xylina* (p. 191).

to other lichenologists; and I doubt not that, if they take the trouble to make similar microscopico-botanical testings, they will meet with many marked instances in which their own results will differ both from mine and from those recorded by authors, like NYLANDER, who have given prominence in their works to chemical reaction as a botanical character.* This arises from the circumstance, already mentioned, that the same species, under different circumstances, yields different colour-results with the same reagent. The following list could have been largely extended had I introduced quotations from similar records relating to the contents of my own Herbarium or of that at Kew. But such plenitude of illustration is, for present purposes at least, quite unnecessary. Omitting all instances of *blue*-reaction with iodine, whether distinct or faint, the other results of iodine-testing may be roughly classified as follows:—

I. *No reaction.*

Thelopsis rubella, Nyl. Exs. 96. According to NYLANDER (Prod. 196), its hymenial gelatine becomes red.
Nephromium cellulosum, Ach. Hermite Island, Cape Horn. According to NYLANDER (Syn. 318), hymenial gelatine becomes blue.
Urceolaria actinostoma, Schær. Exs. 573.
Strigula Babingtonii, Leight. Exs. 35.
Lecidea sphæroides, Smrf., accompanying *Opegrapha atra* in my copy of LEIGHTON'S Exs. 245. According to NYLANDER (Scand. 204), hymenial gelatine gives in different forms of the plant various shades of violet, or wine-red.
L. foveolaris, Schær. Exs. 293.
L. Lightfootii, Ach. v. *commutata*, Schær. Exs. 581. Apothecia here degenerate.
Calicium turbinatum, Schær. Exs. 6.
Verrucaria chlorotica, Ach., Nyl. Exs. 96.
V. elæina, Schær. Exs. 590.
V. biformis, Schær. Exs. 109 (= *V. chlorotica*, Ach.)
V. lævata, Leight. Exs. 198.
V. rupestris, accompanying *V. pyrenophora* in my copy of LEIGHTON'S Exs. 245.
Melaspilea arthonioides, Nyl. Exs. According to NYLANDER (Prod. 159), hymenial gelatine becomes wine-red or bluish.

II. *Reaction violet, red,* or *brown.*

Lecidea luteola, Leight. Exs. 150. Hymenium deep violet, with reddish tinge.
L. Wahlenbergiana, Ach., Leight. Exs. 123. Hymenium very faint purple.
L. cupularis, Ach., Leight. Exs. 122. Hymenial gelatine and asci deep brownish-red; hypothecium (only) blue.
L. abietina, Ach., Leight. Exs. 124. Same reactions as in *L. cupularis*.
L. lurida, Nyl. Exs. 131. Some tissues rose-red, others purple. Schær. Exs. 157, asci pale blue or wine-red; Hepp Exs. 121, asci wine-red.
L. exilis, Hepp Exs. 473. Asci violet.
L. premnea, Ach. (saxicolous), Leight. Exs. 185. Asci lilac or lake-coloured.
L. atro-alba v. *concentrica*, Leight. Exs. 17. Hymenial gelatine violet. According to NYLANDER (Scand. 233), it becomes deep blue.
L. expansa, Nyl., Leight. Exs. 186. Hymenium indistinct blue, with a lilac tinge.
L. coarctata, Leight. Exs. 177. Asci faint blue; contained protoplasm orange-red.

* The majority of lichenological systematists give no attention to chemico-botanical characters, *e.g.*, MASSALONGO, KÖRBER, TH. M. FRIES and MUDD; while NYLANDER, on the contrary, gives them decided prominence, *e.g.*, in his "Lich. Scand."

Lecanora atra v. *verrucoso-areolata*, Schær. Exs. 538. Hymenium pale rose-coloured. Asci give no blue. According to NYLANDER (Scand. 192), the hymenial gelatine of *Verrucaria verrucoso-areolata* becomes yellowish-red.

Physcia stellaris v. *ambigua*, Schær. Exs. 351. Asci-tips pale brown.

Squamaria crassa, Ach., Leight. Exs. 5. Hymenium dirty palish blue or violet.

Opegrapha dendritica, Schær. Exs. 585. Hymenial gelatine pale lilac.

O. vulgata, Ach. v. *vulgata*, Leight. Exs. 194. Asci violet.

Arthonia cinnabarina, Wallr., accompanying *Opegrapha atra* in my copy of LEIGHTON's Exs. 245. Some asci very pale purple.

Verrucaria rimosicola, Leight. Exs. 253. Hymenial gelatine violet; asci not blue.

V. subalbicans, Leight. Exs. 200. Hymenium violet or lilac; hypothecium pale blue.

V. epigæa, Ach. (apparently), accompanying *Squamaria saxicola*, in my copy of LEIGHTON's Exs. 145. Hymenial gelatine palish purple or violet; asci not blue. According to NYLANDER (Scand. 276), hymenial gelatine becomes blue.

V. gemmifera, Tayl. Glenfarg, April 1858. Hymenium pale rose-red; no blue tinge.

On the other hand, I found a very marked *lichenic* reaction—a beautiful and more or less deep blue—with iodine in certain plants, generally regarded by fungologists as *fungi;* but now classed by lichenologists as lichens, on the sole ground apparently of this supposed diagnostic reaction. In *Xylographa parallela* v. *pallens*, Nyl. Exs., the asci and hymenial gelatine gave a beautiful blue. In *X. flexella*, Nyl. Exs., they gave a deep blue; and in *Agyrium rufum*, Nyl. Exs., the hymenium became blue.* I have elsewhere† cited instances of what are still regarded, alike by lichenologists and fungologists, as *fungi*, giving so-called *lichenic* reactions with iodine. *Sphæria ventosaria*, which Mr CURREY considers "a true *Sphæria*," gave me in its hymenium a violet or carmine with iodine; while in a plant lately submitted to Mr BERKELEY, and by him regarded as a "*Peziza* of the tribe *Patellea*," the asci sometimes give a *blue*, sometimes no reaction with iodine.

This *Peziza* (which appears to be new, and for which, if it is so, I propose the specific name *lichenoides*), is associated with *Lecidea parasema* and *disciformis* on the bark of fir trees, Morchone, Braemar, collected by myself in August 1856. The apothecia are apparently sub-stipitate; this appearance being produced by the disintegration of the fibres of the bark on which they are seated. They vary greatly in form and size, being variously angular or oblong, or irregularly subspherical. The margins are involute to various degrees. They are always black; frequently wavy both in surface and outline, and generally thin. The paraphyses are very delicate, filiform, wavy, without coloured tips. The asci are long and sublinear or clavate, springing in groups or tufts from the hypothecium. The sporidia are innumerable in each ascus; atomic, subellipsoid or subspherical. The protoplasm, which is gradually developed into sporidia, closely occupies the cavity of the asci, separated only by a very narrow margin or double contour. Externally the *Peziza* has much of the character of a *Patellaria*, e.g., *P. atrata* (as described in

* In BERKELEY's "British Fungology" (1860) p. 375, both *Agyrium* and *Xylographa* figure among *fungi*, the latter having rank as a subgenus under *Stictis*. *A. rufum* and *X. parallela* are mentioned; but not *X. flexella* (unless it be as *Peziza flexella*, Fr., p. 371), which, however, appears associated with *X. parallela* in NYLANDER's "Prodromus," p. 148, as a *lichen*.

† "Parasitic Micro-lichens;" *Arthonia melaspermella*, p. 284.

my "Otago Lich. and Fungi," p. 427). It has also certain resemblances to a *Hysterium*, e.g., *H. pulicare*, P. The asci and sporidia are similar to those of what, now regarded as a lichen, was by Fries the elder considered a *Peziza*, viz., *Lecidea* (*Peziza*) *resinæ*, Fr. (= *Biatorella*, Mudd, p. 191).* From that *Lecidea* or *Peziza*, *P. lichenoides* differs only in the colour of its apothecium.

The asci of *Abrothallus Smithii*, which Nylander regards as a *fungus*, and Berkeley† as a lichen, though they generally give no colour-reaction with iodine,‡ have, in one instance at least, yielded in my hands the *lichenic blue*, less distinct, however, than in *A. oxysporus*. In the latter species, on the other hand, which is equally by fungologists and lichenologists admitted to be a lichen, while iodine generally developes a vivid and beautiful blue in the asci, this reaction is sometimes either obscure or absent; and the same remark applies to many true lichens, which generally exhibit the typical iodine-reaction.

Sphæria (*Stereocaulicola*), Th. Fries, and *Leptosphæria* (*Lopadiicola*), Th. Fries (Lich. Spitsb. p. 34), give in their hymenium a *yellow* iodine-reaction. But, according to the same careful observer, Fries the younger (in his "Lich. Spitsbergenses," where he has recorded the iodine-reactions of most or many of the lichens therein described), the same reaction§ is exhibited by the following true lichens:—

Leptogium lacerum and tenuissimum;
Collema pulposum;
hymenium, except the sporidia;
L. scotinum; sporidia.
Sphærophoron fragile; medullary tissue (of thallus.)
Gyrophora cylindrica; sporidia.
Lecanora flavida; sporidia and protoplasm of the asci.
L. mastrucata; hymenium.
L. calcarea; do.
Lecothecium asperellum; protoplasm of asci.
Pannaria arctophila; sporidia.
Lecidea pezizoidea; sporidia and paraphyses.
Endocarpon pulvinatum; protoplasm of asci.
Microglæna sphinctrinoides; sporidia.
Staurothele clopima; sporidia and protoplasm of asci.
Thelidium pyrenophorum; sporidia.
Verrucaria extrema; do.
Arthopyrenia conspurcans; protoplasm of asci.

Some of the parasites, which I have grouped meanwhile under *Microthelia*, were lately submitted to Mr Berkeley, in the hope that he might claim a portion at least as fungi proper. But only one of them, what I have described as *M. Nephromiaria*, he refers to *Sphæria* and the *fungi*. The remainder he considers *lichens* belonging to the genera *Verrucaria*, *Celidium*, and *Abrothallus*. To *Verrucaria* he refers *M. Umbilicariæ* and *M. Bæomycearia*; to *Abrothallus* the parasite

* *Quoad* the asci and sporidia it also resembles *Lecanora cervina*, Pers., *Lecidea morio*, Sch., *L. fossarum*, Duf. of Nylander's Exs., and *L. pruinosa*, Sm.

† "I think," writes Mr Berkeley, in Feb. 1869, "Tulasne is quite right in making *Phacopsis*, *Abrothallus*, *Celidium*, and *Scutula* lichens."

‡ *Vide* my "Monograph of *Abrothallus*," Quart. Journ. of Micro. Science, Jany. 1857. Nylander (Prod. 55) remarks, "Nullam enim mihi obtulit *notam lichenoeam*." But what constitutes a "Nota lichenosa?" What *diagnostic* is there characteristic of a *lichen* as contradistinguished from a *fungus*? For my own part, I know of *none*!

§ I have never myself met with in lichens a *yellow* iodine-reaction, which I did or could not regard as the natural (unchanged) colour of the reagent itself.

which affects *Lecanora polytropa* v. *intricata*; to *Celidium*, *M. Stereocaulicola* and the parasites on *Squamaria crassa* and *S. saxicola*.

Some of the parasites formerly grouped by me under *Microthelia* and the *fungo-lichens* have been transferred to the *fungi* proper, *e.g.*, *Sphæria ventosaria*, by Mr CURREY. And it is most likely that other members of that provisional genus or group will from time to time be claimed as true *fungi*. But I find it impossible to perceive the validity of the claim, or the grounds of distinction. To me it appears that *Sphæria* is quite as nondescript or heterogeneous a genus as *Microthelia*, and that it passes into *Verrucaria* by connecting links that defy differential definitions! In the "Treasury of Botany," Mr BERKELEY says that the only distinction between *Verrucaria* and *Sphæria* consists in the presence of thalline *gonidia*; but, as I have elsewhere* shown, no gonidia *can* be present in the large group of parasitic *a*thalline lichens, in which the apothecia—with or without spermogonia or pycnidia—constitute the plant. In the same work he describes *Endothia* as distinguished from *Verrucaria* by its "naked spores." He also apparently regards it as consisting merely of the pycnidia or spermogonia of different lichens (Treasury, p. 1211); but he elsewhere describes "asci" (Brit. Fungology, p. 384)! I am utterly at a loss to reconcile or understand these diverse and puzzling statements. Moreover, if we may judge from NYLANDER's description of *S. homostegia* (Prod. 56), which is flat and maculæform, the *Sphæriæ* are not necessarily papillæform or verrucarioid. Some of them are thus arthonioid; and there are a few parasitic athalline *Arthoniæ* which have quite the facies of *Sphæria homostegia*, *e.g.*, *A. varians*, Dav. (NYL. Scand. 260).

Mr BERKELEY regards *M. Umbilicariæ* and *M. Bœomycearia* (in my specimens) as having a "distinct crust;" or, in other words, a proper thallus. This I quite fail to discover, on repeated examination; the perithecia appearing to me to be indubitably seated directly on an alien (lichen) thallus. No doubt, *M. Umbilicariæ* and *M. Bœomycearia* may be referred to the *Verrucariæ*; but only in the same sense in which the whole group of the *Microtheliæ* may be so transferred, constituting, with *Endococcus* or other pseudo-genera, an athalline (parasitic) section. We have already seen that the botanical "characters" of *Verrucaria* are in great measure negative; while there can be no doubt, as a genus, it is already much too (confusingly) large and heterogeneous.

None of my *Microtheliæ* have the essential characters of TULASNE's genus *Celidium* (as defined in his Mémoire, p. 120, pl. xiv. figs. 9–13, or in my "Otago Lich. and Fungi," p. 448). According to TULASNE, the perithecia are aggregated so as to form maculæ, in the centre of which are seated spermogonia, the spermatia being linear and very slender. In the typical species *C. Stictarum*, Tul. (Mém. p. 122), the iodine-reaction is lichenic; the hymenium becoming bluish, reddish,

* *Arthonia melaspermella*, p. 282.

brownish, or yellowish; but there is no such reaction in the *Microtheliæ*, which Mr BERKELEY refers to *Celidium*. Nor can I conceive any proper ground for assigning the parasite of *Lecanora polytropa* v. *intricata* to *Abrothallus*, which is itself a provisional and pseudo-genus.

Indeed, I am utterly at a loss to comprehend the principles of Mr BERKELEY's classification in the parasites above referred to; and I am led to regard his opinion as another of the many illustrations that may be cited of the diversity between lichenologists and fungologists regarding the nature and affinities of a large and important group of parasites, which have been fully studied by neither class of observers, and are yet, therefore, most imperfectly known. And further, his (quite recent) opinion I accept, as strongly confirmatory of the propriety of establishing a provisional group of *Fungo-lichens*, and of resting contented with placing therein such doubtful organisms as the *Microtheliæ*, which I have hereinafter and elsewhere described,* instead of engaging in fruitless and interminable discussion as to whether they are *fungi* or *lichens*.

When they become more generally studied and more thoroughly known, it may prove that some of the *Microtheliæ* in question are not parasitic or athalline, really possessing a proper thallus; or they may occur—as not a few true lichens do—both in the thalline and *a*thalline state.

Only in certain cases, in describing the parasites, which form the subject of the present communication, have I ventured to assign *names*, viz., in the cases of those which may be considered typical or representative. In other cases—by reason of their resemblances to certain types or to each other, of the imperfections of their structure, or for other causes—I have deemed it preferable for the present not to assign names, either generic or specific, though all these doubtful parasites are grouped provisionally, for convenience in future study and reference, under the pseudo-genus *Microthelia*. I have little doubt that when the parasites in question, as well as the parasitic Micro-lichens and Micro-fungi that have been described by other authors, are more thoroughly studied and known, the *same* type or species will be held to include *several* of those which at present appear distinct. There will be not only a certain reduction, but abolition, of genera and species, of which there is at present a most confusing redundancy.†

Description of Illustrative Specimens.

I. *Torula lichenicola.*

A. Parasitic on thallus or apothecia (or both) of *Lecanora subfusca*, Ach.

1. *Scotch* forms.

(*a*) Corticolous: Craig Choinich, Braemar, Aug. 1856, W. L. L.—Parasitic both on thallus and apothecia in one specimen of ordinary form of the *Lecanora*. The

* "Otago Lich. and Fungi," pp. 436–442.

† An excellent illustration is to be found in the group of "Parasitic *Micro-lichens*," (*antea citat.*)

disk of the apothecium is, however, chiefly affected. Here the parasite is so abundant and so closely aggregated, that it renders the usually smooth disk quite black, and rough-granular or warted; the apothecia then resembling, especially in colour, those of *L. atra*. The spores are sometimes 1-septate or 3-nuclear, resembling many lichen-sporidia.

(*b*) Corticolous: on birch bark, Corramulzie Linn, Braemar, Aug. 1856, W. L. L. —Parasitic on both thallus and apothecia. As in the last case, the disk of the apothecia is frequently quite black and roughened from the growth of the *Torula*.

(*c*) Corticolous: Morchone, Braemar, Aug. 1856, W. L. L.—On thallus only.

(*d*) Corticolous: on firs, base of Ben Lawers, on banks of Loch Tay, June 1856, W. L. L.—Equally on thallus and apothecia. Sometimes, as in cases *a* and *b*, the disk is blackened with the parasite, and resembles that of *L. atra*. Spores bluish.

(*e*) Corticolous: on ash, roadside, Loch Tay, June 1856, W. L. L.—Copiously and generally studded over thallus; much more abundant than the spermogonia of the *Lecanora;* very distinct, black, punctiform bodies; spores generally 2-nuclear, brown.

(*f*) Both corticolous and saxicolous: Kyles of Bute, Aug. 1852, W. L. L.—On thallus; spores indigo-blue; simple (no contained nuclei); narrow, and frequently longer than usual.

(*g*) Corticolous: on firs and other trees, Caerlaverock road, Dumfries, Aug. 1856, W. L. L.—Scattered on thallus of var. *albella*, Pers. Spores large and more numerous than usual; frequently exhibit 2 polar nuclei; that which occupies the upper and broader end of each spore in the spore-chain being generally the larger; or there is only one nucleus at the superior or distal end of the spore.

(*h*) Corticolous: near Dunglass, Cockburnspath, June 1856, Dr Murray Lindsay. —Variety of the *Lecanora*. *Torula* intermixed on thallus with spermogonia, which have not the usual characters of those of *L. subfusca*. Spores bluish. Terminal articulation of the spore-chain, as usual, darkest in colour, with a rounded apex. The other spores, when separated, have squarish or truncated ends, and an oblong form. Occasionally the mature spore contains one or two nuclei. Sometimes the spore-filament developes only one (terminal) articulation; at other times there is no articulation at all—the filament being sterile or abortive—then resembling the paraphysis of a lichen.

(*i*) Corticolous: woods of Blackhall, Strichen, Aberdeenshire, July 1865, Layton. —Copiously scattered over the warts or areolæ of the subverrucose and areolate thallus, but sparingly studding the apothecia.

(*k*) Corticolous: on alder; Pease Dean, Berwickshire, 1856, James Hardy.—Thallus sub-tartareous; many apothecia degenerate; disks eroded. Parasite abundant, both on disk and exciple of apothecia, and on thalline areolæ. Spores with polar nuclei, somewhat resembling certain physcioid sporidia in lichens.

(*l*) Corticolous: Penmanshiel, Berwickshire, February 1857, Hardy.

2. *Irish* forms.

(*a*) Corticolous: near Cork, March 1858, Isaac Carroll. Associated with *Physcia candelaria*, Ach.—Thallus subtartareous, made up of numerous closely-aggregated verruciform areolæ; apothecia mostly degenerate; disk has disappeared, and the apothecia have assumed the appearance of irregular warts. Parasite is copiously studded over both thallus and apothecia, which have alike a black-punctate character. The *Torula* has its usual black, punctiform character. The basal cellular tissue is bluish, bluish-black, or brownish, resembling in this respect the varying colour of the spores. Each spore-filament usually developes four or five articulations, which are oblong and simple, broader above than below. The terminal ones, the largest, are about ·00025″ long, and ·000111″ broad.

(*b*) Corticolous: on old beeches, Castle Bernard, Cork, Carroll. Associated with *Stigmatidium crassum*, Dub.—On both thallus and apothecia (disk and exciple

alike). Parasite very minute, punctiform, black; basal cellular tissue deep indigo-blue. Spore-filaments about ·001″ long, and ·000111″ broad. Spores pale olive to bluish-black—about ·00025″ long, and ·000111″ broad.

(*e*) Corticolous: Ratheonnac, Co. Cork, Mar. 1858, Carroll.—On thalline areolæ and apothecia. Parasite resembles granules of a black powder dusted over thallus, its blackness contrasting strongly with the brown disk of the apothecium and white thallus of the *Lecanora*. Basal cellular tissue, like the spores, bluish-black or indigo colour. Spore-filament, before separation of the spores, ·00066″ long. It frequently throws off only two articulations from its tip; the lower or basal—that is, the longer—portion showing no division. Sometimes there are three articulations or spores; rarely more. The mature spores are ·00025″ long, and ·00014″ broad.

(*d*) Corticolous: Great Island, Cork, Mar. 1858, Carroll.—On periphery of thallus. Spores pale olive or brown; oval, ellipsoid, or oblong; ·00016″ long, and ·000090″ broad.

(*e*) Corticolous: Carrigaloe, Cork Harbour, Mar. 1858, Carroll. Associated with *Physcia pulverulenta*, Schreb.—Both on apothecia and thallus, on the latter somewhat inconspicuous; apothecia degenerate; margin eroded; disk black-punctate with the parasite, which is very numerous and crowded. The *Torula* is here larger than is usual. Basal cellular tissue indigo-blue. Spores brown; ·00025″ to ·00033″ long, and ·00016″ broad—usually simple. Associated with the sporiferous filaments are numerous sterile or non-articulated—probably abortive—colourless, very delicate and linear filaments, which resemble the paraphyses of many lichens. Sometimes they exhibit a faint appearance of septa. A parallel to these sterile filaments is to be found in the sterile hypertrophied sterigmata in the spermogonia of many lichens.*

(*f*) Corticolous: Upper Lakes, Killarney, Mar. 1858, Carroll.—Disk of apothecia destroyed, and the apothecia converted into an uniform dark purple, sterile, degenerate mass.

(*g*) Corticolous: Ardrum, Carroll.—Basal cellular tissue deep indigo. Spore-filaments ·00133″ long, ·000111″ broad; spores ·00025″ long, ·000111″ broad; olive or bluish-brown; oblong, with rounded ends; simple, or frequently with two polar spherical nuclei; sometimes with double contour.

(*h*) Kerry: Taylor in Herb. Mackay.—On apothecia; disks of which become sub-convex and deformed, and frequently as black as those of *L. atra*, from growth of the parasite.

3. *English* or other forms.

Betton, 1805, in Herb. Kew. All disks of the *Lecanora* entirely blackened by growth of the parasite, so that the lichen is apt to be mistaken for *L. atra*.

Körber ("Parerga," p. 470) describes his *Pharcidia congesta* as very frequently parasitic on the apothecia of *L. subfusca* and *L. intumescens*, Rebent., in Germany. It possesses 8-spored asci; the sporidia clavate-oblong, sub-baccillar, 1-3-septate, hyaline. *Lecidea parasitica*, Flk., and *Arthonia varians*, Dav., are also occasionally parasitic either on the thallus or apothecia (or both) of *L. subfusca*.†

B. Parasitic on thallus of *Lecidea canescens*, Ach.

Corticolous: Aghada, Cork Harbour, Carroll.—On portions of thallus free of apothecia. Basal cellular tissue bluish-black. Spores pale indigo-blue or olive; terminal or larger ones ·00041″ long, ·00016″ broad; others ·00025″ long, and ·00011″ to ·00016″ broad.

C. Parasitic on thallus of *Lecidea parasema*, Ach.

On a specimen in Herb. Kew, from Ireland (sub nom. *Opegrapha gemmata*, Ach.) Apothecia of the *Lecidea* confluent and somewhat irregular in form and surface; colour bluish or greenish; sporidia normal. The parasite presents very numerous individuals, closely aggregated, occupying the site of, and otherwise externally resembling, spermogonia; very minute (microscopic), black, punctiform, superficial on, or more or less immersed in, thallus of the *Lecidea*. Spore-filaments about ·0025″ long, and ·00016″ broad,

* *Vide* "Mem. Spermog." Plates IV. V. VI. VIII. XI. XII.

† *Vide* Paper on "Parasitic Micro-Lichens."

varying, however, both in length and breadth. Spores also variable in dimension; simple; oblong, with rounded ends when mature; colourless in the young state, gradually acquiring an olive tint with maturescence; terminal articulation, as usual, deepest in colour. Spore-filaments consist frequently of six articulations—some of which, however, are sometimes atrophied, assuming the aspect of linear threads or ribbons connecting the normal spores.

D. Parasitic on the apothecia of *Lecidea ferruginea*, Huds.

(*a*) Corticolous: Craig Rossie, Dunning, Perthshire, April 1858, W. L. L.

(*b*) Corticolous: on silver fir: Ardrum, near Cork, Mar. 1858, Carroll.

E. Parasitic on thallus of *Lecidea anomala*, Ach.

(*a*) On ash and other trees, associated with *Lecanora subfusca* and *Pertusaria communis;* near Dunglass, Cockburnspath, Berwickshire, Dr Murray Lindsay, June 1856. The parasite here is associated with, and apt to be mistaken for, spermogonia. Terminal spores blackish; rounded at upper end; sometimes containing enclosed nuclei.

(*b*) Dunglass; thallus of the *Lecidea* white and granulate. *Torula* intermixed with spermogonia.

F. Parasitic on thallus of *Lecanora varia*, Ach.

Sub *Parmelia* in LEIGHTON's Exs. No. 176; on fir bark, Twyford Churchyard, Shropshire. Intermixed with spermogonia, with which the parasitic perithecia are apt to be confounded. In the same perithecia, moreover, the spore-filaments of the *Torula* are associated with the sterigmata of the *Lecanora*, taking here the place of the sterile hypertrophied sterigmata of lichen-spermogonia.*

G. Closely associated with, but not parasitic on, various corticolous Lichens.

(*a*) On or with *Arthonia melaspermella*, Nyl.; corticolous; Weybridge, Surrey, Currey. In the "Journal of the Linnean Society" (Botany, vol. ix. pp. 271 and 286, tab. 6, figs. 2 *c*, 3 *c*, and 6), I have erroneously described and figured the parasite as the *Pycnides* of the *Arthonia*. Here the articulations of the spore-filament are bluish. It is impossible to determine whether or not there is a proper thallus of the *Arthonia*, on which the *Torula* occurs.

(*b*) With *Opegrapha atra*, Pers.; in SCHÆRER's Exs. No. 634; right hand specimen in my copy. Spores brown; smaller than is usual.

(*c*) With *Verrucaria epidermidis*, Ach., Malham, Yorkshire, Oct. 1857, Dr Carrington. —Spore-filaments of two or three articulations only. Terminal spores ·00025″ long, very narrow and granular.

In the foregoing cases (*B* to *G*) the parasite has the same essential characters that it exhibits when frequenting its much commoner host—especially in Ireland —*Lecanora subfusca*.

It is probable that the *Torula*, which is described as destroying the apothecia of *Biatorina fraudans*, Helb., in Spitzbergen (TH. FRIES in "Lichenes Spitsbergenses," p. 35), as well as that referred to in NYLANDER's "Synopsis" (p. 58), is *Torula lichenicola*. But of neither FRIES' nor NYLANDER's plants have I seen specimens. *T. lichenicola* has a suspiciously close resemblance to what NYLANDER describes in his "Prodromus" (p. 86), as the *Pycnides* of *Sphæria epicymatia*—a parasite, which, he says, is common on *Lecanora subfusca*, but which I have never found. In the same work (and same page) he mentions *Torula monilioides*, Bon.; but I have no means of knowing whether this is *T. monilioides*, Cd., or *Bispora monilioides*, Cd., of BERKELEY's "British Fungology" (pp. 326 and 327); or *T. lichenicola;* or some plant—fungus or lichen—different from either.

* *Vide* p. 532 and foot note.*

II. *Coniothecium lichenicolum.*

A. Parasitic on thallus of *Lecanora tartarea*, L.

(*a*) Morchone, Braemar, Aug. 1856, W. L. L.—On isidioid, sterile states of the thallus of the *Lecanora*. Spores deep brown; sometimes spherical and simple; frequently 8-shaped (didymous); frequently also in moniliform chains, as in *Torula lichenicola*, or in groups of four or three.

B. Parasitic on thallus of *L. parella*, Ach.

(*a*) Blackcairn Hill, near Newburgh, Fifeshire, May 1858, W. L. L.—On sterile forms of thallus of the *Lecanora*. Parasite more irregular in surface and outline, more crowded, and more frequently confluent than is usual. Occurs in groups on different parts of the thallus of the host. Spores sometimes 8-shaped (didymous), ·00025″ broad, ·0005″ long; more generally single or simple and spherical, about ·00016″ in diameter.

(*b*) Morchone, Braemar, Aug. 1856, W. L. L.—On sterile states of thallus, sparingly scattered, sometimes only about periphery of thallus. Parasite has sometimes an apothecioid aspect, its black mass being girt with an obscure thalline ring. Occasionally it appears as if seated in thalline verrucæ, and is so small as to resemble spermogonia. At other times it resembles the smaller urceolate apothecia of *Lecanora cinerea*; and if the thallus of *L. parella* were more generally covered with the parasite, it might, at first sight, be confounded with a form of *L. cinerea*.

(*c*) Glen Dee, Braemar, Aug. 1856, W. L. L.—On isidioid states of thallus. Parasite mostly large and flattish, with very ragged outline in the old state, resembling spots of soot; in young state, is regularly papillar. Has a close resemblance to *Spilomium Graphideorum*, Nyl., in size and irregularity of outline and surface.

C. Parasitic on *Isidium corallinum*, Ach.

(*a*) Old Wall, Craigie Hill, Perth, May 1856, W. L. L.—The surface of the thallus shows little distinction between the constituent isidia, which are so closely aggregated as to form a general white subcretaceous mass, sometimes obscurely divided into areolæ. Parasite occupies generally the centre of these areolæ where they occur, or is studded generally over surface of thallus, as black, round, convex masses, varying in size. Spores in all cases show double contour; in age acquire an irregular or corrugate outline; colour generally brown, or blackish-brown, graduating into olive; sometimes very pale or almost colourless in young state.

It appears to be the same parasite which occurs on *Isidium corallinum* in Mougeot and Nestler's Exsic. No. 74; which *Isidium* is there probably referable to *Lecanora parella*. The parasite resembles black apothecia, which have been doubtless by lichenologists of the pre-microscope era mistaken for the "fruit" of the *Isidium* or *Lecanora*.

The columns of *Isidium corallinum* have apices that are frequently coloured more darkly than the body of the isidia; which coloured apices were often mistaken by the earlier lichenologists for apothecia or "fruit" of different kinds, and which often have a close resemblance to some forms of spermogonia. The plant consists, when typically developed, of a series of minute, round, perpendicular columns, which become by close appression sometimes subangulose, and may even lose their individuality, coalescing into a general subcretaceous mass, $\frac{1}{8}$″ to $\frac{1}{4}$″ thick. Where such coalescence does not take place, there is seen on cross section, either natural or artificial—a honeycomb-like arrangement of columns—similar to the basaltic columns of Staffa or the Giant's Causeway on a microscopic scale. Where the apices are not cut off by natural cross section or erosion, they are discrete and papilliform, resembling, on a small scale, the young ramuscules of *Sphærophoron*, as these are figured in my "Observations on New Zealand Lichens" (Pl. lxii. fig. 5).* The colour of the isidia varies considerably; sometimes, especially in specimens long preserved in the

* Transactions of Linnean Society of London, vol. xxv.

Herbarium, they are flesh-coloured; more generally they are grey. The colour is always deepest at the apex, gradually disappearing below, where the bodies of the columns coalesce into a chalky mass. The tips of the papillæ, which form the upper or free extremities of the columns, are generally brown; but this tint varies in depth or distinctness, being frequently very obscure.

D. Parasitic on thallus of *Lecanora atra*, Ach.

Saxicolous: Pentland Hills, Edinburgh, Aug. 1855, W. L L.—No part of this parasite gives a blue reaction with iodine.

E. Parasitic on thallus of *Diplotomma calcareum*, Weis.

Clapham, Yorkshire, Dr Carrington, Oct. 1857.—What appears to be the *Coniothecium* is seated on the thalline areolæ, where they are at all distinct. It is black, generally round, sometimes irregular in form, *e.g.*, becoming sub-arthonioid; generally flat; seldom, and only in young state, verrucarioid or papillæform; sometimes confluent; superficial, the base only immersed. The parasite is sometimes indistinguishable from the apothecia of its host, save as to the inferior size of the *Coniothecium*; its size, however, is variable; it generally wants the thalline margin—which is, however, sometimes comparatively distinct, girding the apothecia. Here the *Coniothecium* exhibits no reproductive structure.

The same *Diplotomma* is in England the seat of the parasitic *Microthelia rimosicola*, Leight. (Mudd, "Brit. Lich.," p. 308, plate v. fig. 129), which has 8-spored asci, and oblong, 3-septate, brown sporidia. My note-book records, on the Yorkshire plant, the presence of *Pycnidia*, containing stylospores.

F. Parasitic on thallus of *Lecanora cinerea*, L.

Kerry, Taylor (in Fl. Hibern., sub-nom. *Spiloma sphærale*).—Thallus of *Lecanora* sterile. The parasite is scattered about the periphery of the alien thallus, much more abundantly than the spermogonia of the *Lecanora* usually are. In the young state the *Coniothecium* is immersed, and then frequently resembles closely some forms of the spermogonia of *L. cinerea*; but gradually it becomes emergent and epithalline, resembling, according to its size and form—whether flattish or sub-globose—the black apothecial disks of a sessile *Calicium* or a *Lecidea*. It contains no reproductive structure, exhibiting under the microscope only its deep-brown, basal, cellular tissue.

G. Parasitic on sterile conditions (which are variously isidioid or variolarioid) of the thallus of several *Lecanoræ*.

It is in general impossible to determine in these cases what is the *species* of *Lecanora*. Sometimes only it appears to be *L. glaucoma*, *L. parella*, or *L. tartarea*. In no case is the isidioid condition so marked as to bring the thallus under the category (*C*) of *Isidium corallinum*.*

(*a*) Scuir-na-gillean, Skye, Aug. 1856, W. L. L.—Black papillæ of parasite very variable in size; generally very distinct. Spores of a sooty-brown colour.

(*b*) Saxicolous: Moors east of Reykjavik, Iceland, June 1860, W. L. L.—Here, again, no distinct reproductive structure is visible. The parasite is large, black, and conspicuous by contrast of colour on the whitish or grey thallus, having somewhat the characters of the apothecia of a *Lecidea* of the *parasema* or *contigua* group; much more irregular in form, however, and variable in size; consisting, moreover, apparently of aggregations, or glomeruli, of irregular papillæ; semi-immersed in the thalline areolæ, but projecting by an irregular, rough, granular surface above their level.

(*c*) Morchone, Braemar, Aug. 1856, W. L. L.—Abundant and in fine condition.

(*d*) North Wales, Rev. H. Davies (sub-nom. *Isidium microsticticum*, E. B. and Lich. Brit.) in Herb. Kew.—Parasite seated on, and partly in, small thalline papillæ; in which latter case it possesses a pale thalline border; small, black,

* I have recently (August 1869) found *Coniothecium* frequent on the sterile saxicolous thalli of *Lecanoræ*, both in the northern and southern Highlands, *e.g.*, Helmsdale, Sutherlandshire, and St Mary's Loch district, Selkirkshire. In these districts the thalli in question are most probably referable to *Lecanora parella* or *glaucoma*, or both. On similar sterile thalli the parasite is *common* throughout Scotland, and probably throughout Britain.

lecidioid, convex, scabrous—studded over the thallus of the host. Spores brown; very irregular; concatenate, or Sarcinate, in groups of 4-woolpack-like masses, similar to those of *Sarcina ventriculi*, Goodsir.

(*e*) Kinnoull Hill, Perth, May 1856, W. L. L.—Associated with *Squamaria gelida*, L. Parasite occurs on an areolate, white, crustaceous thallus, sterile of apothecia, referable, doubtless, to some *Lecanora*. The *Coniothecium* has quite the aspect of some species of *Microthelia*, *e.g.*, *M. rimosicola*, Leight. Spores chestnut-brown; have the appearance of portions of cellular tissue,* composed of irregular, subcubical cellules.

(*f*) Barmouth, N. Wales, June 1856, Leighton (sub-nom. *Spiloma*).—Referred by Mr Cooke to "*Sporidesmium* sp." in my Herbarium.

H. Not parasitic on, though closely associated with, various saxicolous lichens. Roadside between Sligachan and Portree, Skye, Aug. 1856, W. L. L.

Some at least of the parasites which I have referred to *Coniothecium lichenicolum* have apparently been mentioned, if not also described, by various of the earlier lichenologists, under most diverse names. Specimen (*d*) has the characters of *Isidium microuticticum* of "English Botany" and the "Lichenographia Britannica;" (*b*) has quite the appearance externally of *Spiloma nigrum*, Leight. and "English Botany,"† and of *Spilomium Graphideorum*, Nyl.‡ A plant from Clapham, Yorkshire, Dr Carrington, is apparently—partly at least—*Sclerococcum sphærale*, Fr.; § and *Cyphelium* (or *Acolium*) *corallinum*, Hepp Exs. No. 531, and Körber's "Parerga," pp. 299 and 465. *Coniothecium lichenicolum* agrees also with *Variolaria conspurcata*, Engl. Bot., tab. 1993 (at least) with the characters of the plate.

Coniothecium lichenicolum has a close resemblance to some forms of *Sporidesmium;* and it is quite likely that there is a lichenicolous *Sporidesmium*, hitherto undescribed, for which the specific name *lichenicolum* would be appropriate. I have not, however, at present sufficient data for determining this. What appears to me to be *Con. lichenicolum*, occurring on the white, crustaceous, sterile thallus of a *Lecanora* from Barmouth, N. Wales, Leighton, June 1856—in my Herbarium—was (as already stated) labelled by Mr Cooke "*Sporidesmium* sp." Two of the *lichens* of the earlier lichenologists have been transferred by fungologists to the genus *Sporidesmium*, viz, 1. *Lepraria nigra*, Engl. Bot., t. 2409, of 1st edition, which is the *Coniothecium effusum*, Cd., and the *Sporidesmium*

* *Vide* p. 519 and foot note.*

† P. 45, tab. 1984, 2d ed., 1843.

‡ The specimen of *S. Graphideorum*, Nyl., contained in my copy of his "Herb. Lich. Paris," No. 72 (from Fontainebleau, on a white, mealy thallus—of some *Graphis*—coating a very rugged bark, and associated with a *Hysterium*), has the external characters, on a large scale, of a *Spiloma*. *Spiloma nigrum*, var. *variolosum*, Turn. & Borr. in Leighton's Exsic. No. 259, closely resembles it, though Leighton's plant is more crowded and more irregular in outline. The French *Spilomium* is quite visible to the naked eye; variable in size; very black; irregular in outline, though generally round; sometimes confluent; surface usually more or less convex and rough, as in *Coniothecium*, from the projecting powdery or granular spore-masses. The spores are spherical or oval; generally with double contour; simple; deep brown; about ·00025″ in diameter; sometimes slightly irregular in outline; cohering frequently in rouleaux like blood-corpuscles.

§ = *Spiloma sphærale*, Ach., but not *Buellia saxatilis*, Schær. (Nylander, "Prod." p. 140), according to Th. Fries ("L. Arct." p. 116).

Lepraria, Berk. and Broome, of BERKELEY's "Brit. Fungology," p. 327; and 2. *Spiloma melanopum*, Engl. Bot. t. 2358 of 1st edition, which is the *Sporidesmium melanopum*, Berk. and Broome, of BERKELEY's "Brit. Fungol." p. 327.

III. *Sphæria ventosaria*, Linds. "Obs. on Otago Lichens and Fungi," p. 439;* "Obs. on Greenland Lichens."†

Parasitic on the thallus of what appears to be *Lecidea grossa*, Ach., Ingleby, Cleveland, Yorkshire, Mudd; in my Herbarium. Occurs as minute, black papillæ, intermixed with the apothecia of the *Lecidea*. Externally the parasite has the character, as it has the position, of certain verrucarioid spermogonia, *e.g.*, in the genus *Lecidea*; and it has also the facies of *Endococcus* or *Microthelia*. No distinct asci are visible; but the hymenial gelatine showed a beautiful *carmine or violet colour with iodine*, just as many true lichens do. Sporidia minute, pale brown, oblong, with rounded ends, with or without double contour, according to age; 1-septate—septum indistinct in young state. Mr CURREY regards it as "a true *Sphæria*. . . . There are certainly thecæ filled with very numerous, brown, 1-septate sporidia, 0·0003". . . . The perithecia are so minute and so scattered, that it is extremely difficult to detach them for examination." He refers the parasite to *S. ventosaria*; but the perithecia are very different from those common in the same parasite on *Lecanora ventosa*.

IV. *Microthelia*.

1. *M. Cookei*. Parasitic on thallus of *Lecanora crenulata*, Dicks., Barrack wall, Chichester. W. C. Cooke, March 1866. The parasite occurs on the thicker, whiter portions of the thallus, as black, papilliform, scattered conceptacles. The hymenium gives no blue with iodine; its constituents are very indistinct, unless under the action of iodine or other colouring matter. Hypothecium is colourless. Paraphyses appear rather like a mass of striated jelly than as distinct, filiform threads—resembling in this respect those of *Pertusaria*. Apices not coloured. Asci polysporous, saccate, bulging irregularly, ·0018" long, ·00045" broad. Sporidia very small, ·00022" long, ·00009" broad; colourless; oblong-ellipsoid; 1-septate, sometimes simple.

M. Cookei externally resembles *M. rimosicola* of MUDD's Exsic. No. 301; but the asci in the latter are 8-spored. It differs from all the *Microtheliæ* mentioned in MUDD's "Manual of British Lichens," in having colourless sporidia; but in other points it resembles *M. pygmæa*, Körb., which is also polysporous.

2. *M. Stereocaulicola*. Parasitic on thallus of *Stereocaulon paschale*, L., Glen Derrie, Braemar, Croall, July 1854.

The free ends of some of the podetia of the *Stereocaulon* are the seat of bullose-looking deformities or expansions, which are compound solid verrucæ, made up of an aggregation of minute wartlets, of the same colour as the normal

* Transactions of the Royal Society of Edinburgh, vol. xxiv.
† Transactions of the Linnean Society, vol. xxvii. (1869).

podetium and its squamules. These thalline deformities closely resemble those which are occupied by spermogonia in the same *Stereocaulon* and in *S. denudatum*, Flk., as they are figured in my "Memoir on Spermogones" (plate v. figs. 33 and 36). Moreover, the parasite closely resembles the spermogonia in question in its conceptacles forming brown or black verrucarioid papillæ; sometimes visible as mere points, the body immersed in the wartlets of the thalline deformities of the *Stereocaulon*—one or two in each wartlet—the apex alone projecting. Asci not blue with iodine, ·0023″ long, ·00066″ broad. No distinct paraphyses. Sporidia, ·0005″ long, ·00033″ broad; obovate; colourless when young, becoming olive or brown with age; 1-septate.

Th. Fries* has described, without naming, a *Sphæria* as parasitic on the thallus of *S. alpinum*, Laur., in Spitzbergen; whose sporidia, however, distinguish it from the *Microthelia*. The hymenium of the *Sphæria*—which may appropriately bear the specific name *Stereocaulicola*—becomes yellow with iodine. The sporidia are blackish, four in each ascus, oblong-elongate, 3–5-septate, becoming submuriform by longitudinal division of the loculi. Körber (in his "Parerga," p. 455), describes *Scutula Stereocaulorum*, Anzi, as parasitic on *Stereocaulon alpinum* and *S. fastigiatum* in the Alps of Northern Italy. But its sporidia are smallish, narrowly ellipsoid, subcymbiform, 1-septate, and colourless. Also his *Polycoccum Sauteri* ("Parerga," p 470) as occurring on the protothallus and thallus of *S. condensatum*, Hffm. Sporidia small, dacryoid, 1-septate, brownish.

One or more species of *Sirosiphon* (an *alga* belonging to the family *Sirosiphoniaceæ*, of the *Palmellaceæ* or *Protophyta*, according to Rabenhorst (Fl. Europ. Algar. Aq. dulcis, &c. p. 289), are parasitic on some species of *Stereocaulon*. Thus *Sirosiphon saxicola*, Næg. (perhaps the *S. crustacea*, Ag., of Rabenhorst, *op. cit.* p. 289), is parasitic on *Stereocaulon denudatum* in Scandinavia (Nyl. "Scand." p. 65); while a *Sirosiphon*, not named, and which may be also *S. saxicola*, grows on the podetia of *Stereocaulon vulcani*, Bor., and was mistaken for cephalodia by Fries (Nyl. "Lich. Exotic." p. 252). The parasite occurs as blackish pulvinuli, which are quite different in anatomical constitution from cephalodia; the latter always exhibiting on section the structure of—1. The cortical; 2. Gonimic; and 3. Medullary, tissues of the lichen-thallus.

3. *M. Umbilicariæ*. Parasitic on the sterile thallus of *Umbilicaria pustulata*, Hffm.; collected in Norway as commercial "Pustulatous moss." The parasite is copiously studded over both the bullæ and interspaces of the thallus, as black, papilliform conceptacles, varying somewhat in size and form; semi-immersed; comparatively conspicuous on the gray, cracked thallus of the host. Paraphyses very delicate and indistinct, as in *Verrucaria*. Asci very faint *violet with iodine*; while the hymenial gelatine shows more distinctly the same tint with the same

* "Lichenes Spitsbergenses," p. 36. *Vide* also author's "Observations on Greenland Lichens."

reagent. Large quantity of oil globules intermixed with the hymenial constituents. Contents of young asci colourless, gradually assuming a brown tint as the protoplasm becomes distinctly partitioned into sporidia. Latter are, in maturity and when free, deep brown, generally 1- sometimes 2-septate; oval or broadly ellipsoid. It is possible the parasite on *U. pustulata* may prove referable to what KÖRBER describes in his "Parerga" (pp. 40 and 469) as *Tichothecium grossum*, which affects the thallus of *U. arctica*, Ach. The latter species of *Umbilicaria* is the seat also of *Dothidea lichenum*, Smrf., which TH. FRIES (Lich. Arct. p. 166) suggests may be KÖRBER's *T. grossum*. I have not met with any description of SOMMERFELT's plant. Its name, *D. lichenum*, is apt to be confounded with that of MASSALONGO's *D. lichenicola* ("Richerche," p. 45, fig. 81), which affects the apothecia of *Pachyspora viridescens*, Mass.; has 1-septate sporidia, that, however, are colourless, elliptic-oblong, and slightly curved; and is apparently, therefore, a different plant.

4. *M. Nephromiaria*. Parasitic on thallus, and (back or under side of old) apothecia of *Nephromium cellulosum*, Ach.; Hermite Island, Cape Horn, Dr Hooker, Antarctic Expedition, 1839–43.

Parasite occurs as very minute, black, punctiform or papillæform, semi-immersed conceptacles, dotted over the thalline rugæ, or on the back of the old apothecia. It is sparingly scattered about the centre of the thallus, more plentifully on the thalline underside of the apothecia. The black apex is the only part that is superficial, the body being immersed. According to their size, and the form of the ostioles, the perithecia resemble those of many lichen-spermogonia, or of some of the smaller *Verrucariæ*. They vary in size, and are sometimes confluent, though generally scattered. The asci are sac-shaped like those of *Arthonia*, bulging broadly, not blue with iodine. Hymenial gelatine *violet under iodine*. Paraphyses indistinct, and as in *Verrucaria*. Sporidia 3-septate, colourless, fusiform; eight in each ascus.

The asci and sporidia agree with those of what I described in my "Memoir on Spermogones" (p. 135) as *Lecidea Alectoriæ;* and as the plants otherwise appear essentially the same, I merge the two in a single type, and abolish both the generic and specific* designations as inappropriate. *M. Nephromiaria* also resembles externally *M. Cargilliana*,† but the simple, spherical, brown sporidia of the latter sufficiently distinguish it.

Also having 3-septate sporidia in sac-shaped asci is a parasite which covers copiously, with its punctiform perithecia, some of the laciniæ of *Physcia ciliaris*, L., in SCHÆRER's Exs. No. 388 (sub-nom. *Parmelia ciliaris:* the lower of two specimens in my copy =ed. alt. immut., 1840). The body of the perithecium is

* What was originally designated *Alectoria*, is now known as *Neuropogon, Taylori* (NYL. "Syn." p. 273).

† "Otago Lichens and Fungi," p. 441, pl xxx. figs. 31–34.

immersed in the thallus of the host, only the black apex being visible on the surface. The whole length of some laciniæ is dotted over with the parasite, while others are unaffected. My notes, made in 1857, do not record, unfortunately, the colour, size, or form of the sporidia.

5. *M. rugulosaria*. Parasitic on apothecia of *Placodium rugulosum*, Nyl. ("Chil." p. 193;) Tasmania, Stuart, in Herb. Kew; saxicolous.

The apothecia, which are of a deep orange-red, are abundantly studded over with the very minute, black, punctiform, or papillæform conceptacles of the parasite. The latter are prominent under the lens, especially when the apothecia are moistened, from the striking contrast of colour. They are semi-immersed in the epithecium of the *Placodium*. Paraphyses very delicate and filiform. Asci as long as the paraphyses; ·0016″ long, ·0005″ broad; 8-spored. Sporidia ·0004″ long, ·00016″ broad; 1-septate; soleaform;* brown. Both asci and sporidia resemble those of the microspermous and microsporous forms of *Abrothallus Smithii*.

(*a*) Having similar sporidia—brown, soleaform, ·0005″ long, ·00016″ broad—is a similar parasite (which may prove referable to *M. rugulosaria*, or to the same type to which it may hereafter itself be referred) that affects the thallus of *Thelotrema lepadinum*, Ach.; on Holly, Ireland, Carroll. Its perithecia are black and sub-verrucarioid, resembling those of *Verrucaria fusiformis* or *epidermidis*. These sporidiiferous perithecia are accompanied by others containing stylospores, like some of those of *Lecidea abietina;* narrowly ellipsoid; ·00033″ long, ·000111″ broad; pale yellow. Both forms of perithecia are probably referable to the same parasite.

The thallus of *T. lepadinum* is also affected by *Nesolechia Nitschkii*, Körb. (Par. p. 462), which has minute, oblong-sub-bacillar, simple, hyaline sporidia; and by *Stenocybe eusporum*, Nyl.

(*b*) Another Irish specimen, sent me as a *Sphæria*, by Carroll, in August 1856, from Mangerton, County Kerry, on a tartareous, white, much areolate, sterile thallus (which cannot be referred to its proper species), has figure-8-shaped, 1-septate, deep brown or olive sporidia or spores; ·00033″ long, and ·00025″ broad. The perithecia are largish and verrucarioid; very black; varying greatly in size and form; in the young state papillæform, in age flattened and lecidioid; they are scattered on the thalline areolæ, and are very conspicuous on the whitish or cream-coloured thallus.

The plant has externally the facies of *Coniothecium lichenicolum*, to which it may really belong.† Mr Cooke, who examined it, describes the contained reproductive corpuscles, which may be either sporidia or spores, as "Toruloid spores."

* Frequently erroneously written *solæform*. *Soleæform* sporidia are necessarily 1-septate. *Vide* definition of the term in "Otago Lich. and Fungi," foot note, p. 447.

† *Vide* p. 519.

Both thallus (of the host) and disks of the parasite closely resemble those of Barmouth (North Wales) specimens of *C. lichenicolum*.

(*c*) *Lecanora cenisia*, Ach. (which = var. *atrynea*, Ach., of *Lecanora subfusca*, Ach. according to NYLANDER) from Ayton, Cleveland, Yorkshire, Mudd, in my Herbarium, bears on its apothecia a minute punctiform parasite, containing soleaform sporidia; here, however, of a pale, brownish-yellow hue.

(*d*) On thallus of *Lecidea pachycarpa*, Duf., Ireland, Admiral Jones, June 1858. Parasite is small, black, and Lecidioid, resembling certain lichen-spermogonia of the flat, discoid type. Hymenium gives no blue with iodine. Paraphyses filiform, indistinct, wavy, not coloured at tips; asci ·0040″ long, ·00083″ broad; sporidia colourless when young, gradually acquiring an olive or brown tint with age; soleaform; ·00066″ to ·0010″ long, ·00033″ broad.

It is impossible to confound the perithecia or sporidia of the parasite with the apothecia or sporidia of the *Lecidea*. The apothecia in question are very large and conspicuous; while the sporidia of the *Lecidea* are also very large—·0040″ long, and ·00133″ broad; 7-septate, colourless, oval-oblong. The asci of the *Lecidea* are, moreover, 1-spored, ·0050″ long, ·0014″ broad, becoming pale blue with iodine. Its paraphyses are indistinct; obscured about their irregular tips by much granular, greenish pigment-matter, and throughout the length of their bodies by the same colouring matter (in quantity), and by oil globules.

6. *M. Stictaria*. Parasitic on thallus of *Sticta Freycinetii*, Dél., Campbell's Island, Dr Hooker, Antarctic Expedition (sub-nom. *S. scrobiculata*). The conceptacles of the parasite are small, black, and superficial, easily detached. Asci 8-spored, small, subsaccate, *deep violet with iodine*. This is, at least, an unusual reaction if the plant is a *fungus*; while it does *not* appear to possess other characters of a *lichen!* Sporidia brown, soleaform (1-septate),* resembling those of *M. rugulosaria*, but much smaller.

7. *M. parietinaria*. Parasitic on thallus of *Physcia parietina*, L., Cottishall, in Herb. Kew; on a single fragment of the *Physcia*. Parasite occurs as minute, black perithecia, variously punctiform or papillæform according very much to size; partly immersed; much crowded on the thallus of the host; variously resembling lichen-spermogonia (*e.g.* of some *Lecideæ*), or the smaller *Verrucariæ*. Asci not seen; sporidia brown, 1-septate, ·0005″ long, ·00016″ broad; soleaform as in *M. Stictaria* and *M. rugulosaria*; nearly of same size as those of latter, but larger considerably than those of former. *M. parietinaria* must not be confounded with *Phacopsis varia*, Tul. (Mém., p. 125, tab. 14, figs. 1–3; *Celidium*, Körb., Parerga, p. 456), which has 3-septate, ellipsoid, colourless sporidia, according to TULASNE; but oblong and becoming brown, according to KÖRBER.

8. *M. Bœomycearia*. Parasitic on sterile thallus of *Bœomyces rufus*, DC., Bal-

* Frequently erroneously written *solæform*. *Soleaform* sporidia are necessarily 1-septate. *Vide* definition of the term in "Otago Lich. and Fungi," foot note, p. 447.

thayock Woods, Perth, June 1856, W. L. L. Thallus consists of a series of minute, irregular pulvinuli, of a buff colour, on which the black perithecia of the parasite are conspicuous by contrast. This contrast is rendered greater, however, by the circumstance that the patches of thallus occupied by the parasite are lighter in colour than the rest of its surface. The parasitic perithecia are extremely minute and punctiform, so closely scattered as to give the thallus the appearance of being covered with granules of coal-dust. Sometimes they are so numerous and so closely aggregated as to become confluent in very irregular patches. Under moisture, the single perithecia assume a papillæform character. The *Microthelia* cannot be confounded with the young apothecia of the *Bæomyces*, which are brown, and much larger in almost all stages of growth. Sporidia of the *Microthelia* dark brown, oval; 3-septate; frequently or generally constricted at or opposite the septa. The thallus of the same *Bæomyces*, as well as that of *B. roseus*, Pers., is affected by *Nesolechia ericetorum*, Fw. (Körb., Parerga, p. 461), whose sporidia are minute, ellipsoid, sub-bacillar, simple, and hyaline. On *B. rufus* also occur *Lecidea parasitica*, Flk., *L. scabrosa*, Ach., *L. inquinans*, Tul., and *L. arenicola*, Nyl., as well as *Thelocarpon epithallinum*, Leight.*

9. *M. atricola*. Parasitic on thallus of *Lecanora atra*, Ach., on red sandstone, Derriquin, County Kerry, Taylor in Herb. Moore, Dublin; associated with *Lecanora periclea*, Ach. (= var. of *L. sophodes*, Ach.). The parasite has the facies of a *Verrucaria* or *Endococcus*; its perithecia being minute, distinct, black cones, with sometimes a flattish or depressed apex; becoming occasionally irregular in form; seated *on*, scarcely *in*, the thallus of the host. Asci ·0020″ long, ·00066″ broad; crowded with innumerable sporidia. Sporidia spherical, simple, deep brown, about ·000083″ in diameter; resembling those of many *Calicia*.

L. atra, on the Continent,† is occasionally the seat of another parasitic fungus, *Gassicurtia silacea*, Fée (Nylander, Prod. p. 91; Lich. Parisienses, No. 150), which either affects the thallus or apothecia, sometimes occupying the place of the latter. The parasite consists of black filaments, forming in the aggregate brush-like masses, similar to the apothecium of *Sphærophoron* in some of its old stages of growth; it has a *Spilomatic* or glomeruliform facies. In the only authentic specimen I have examined (in Nylander's Herb. Lich. Paris., No. 150; on stones in Forest of Fontainebleau), the thallus is sterile, consisting of a series of cushion-like areolæ, more or less scattered, seldom closely aggregated. Some of these white tartareous verrucæ are occupied by the parasite, which is very black, irregular in form, and easily distinguishable under the lens from the apothecia of the *Lecanora*; surface generally more or less subgranular. The spores are deep brown;

* *Vide* Paper on "Parasitic Micro-Lichens" (*antea citat.*).

† And in New Zealand; Lindsay, "Obs. on N. Z. Lichens," p. 540.

spherical, ·00033″ in diameter, generally with double contour—rough or granulate externally—resembling, in some respects, those of *Sphærophoron*; than which, however, they are much larger. Sometimes in age they become oval and unequally figure-8-shaped, as if in process of fission. What appear to be the nuclei of the spores also occur abundantly, as much smaller spherical corpuscles, ·00016″ to ·00020″ in diameter, pale yellow, gradually becoming olive and brown, exhibiting like the spores themselves double contour. NYLANDER describes (Prod. 91) its spores as black and spherical, and thinks the plant should be referred to the genus *Spilomium* * (*Uredineæ*).

10. *M. vesicularia*. Parasitic on thallus of *Lecidea vesicularis*, Ach., Switzerland; in Herb. Kew. Occurs as small but distinct black papillæ, closely aggregated; superficial; scarcely immersed; externally resembling those of *M. pygmæa*. It resembles that species further in its asci being polysporous; but the sporidia are 1-3-septate, according to age; most usually the latter in maturity. The smaller ones, when 1-septate, resemble those of *M. pygmæa*. Hymenium gives no blue with iodine. Asci ·0027″ long, and ·00083″ broad. Sporidia ·00033″ to ·00050″ long, ·00016″ broad, but variable in size; fusiform or oval; brown.

Also having brown, minute sporidia, which are here, however, oval or ellipsoid, and are sometimes concatenate, is a parasite that affects the sterile thallus of what appears to be a *Pertusaria*, in Balthayock Woods, Perth, June 1856, W. L. L. No part of the hymenium gives blue reaction with iodine. The thallus of *Pertusaria communis* is the seat of a parasitic fungus, *Spilomium Pertusariicolum*, Nyl. (Enum. Génér. p. 91, and Synopsis, p. 144), which is conidiosporous, the spores being oblong and blackish. The same thallus is affected by *Lecidea parasitica*, Flk., *Sphinctrina turbinata*, Pers., and var. *microcephala*, Nyl., *Trachylia stigonella*, Ach., *Pseudographis elatina*, Ach., and *Opegrapha anomæa*, Nyl.†

My Herbarium contains a number of other lichenicolous parasites, having (more or less) characters resembling those of the *Microtheliæ* above described. But I cannot at present venture to assign names, or a specific place in classification, on account of the imperfections of their reproductive structure, the doubtful nature of their habitats, or other difficulties as regards their determination or description. The following are illustrations of this heterogeneous group of parasites:—

1. Associated with *Verrucaria epidermidis*, Ach., var. *analepta*, Ach.; banks of Crinan Canal, Argyleshire; on birch; Aug. 1856, W. L. L.—It has quite the thallus and aspect of a *Verrucaria* (*e.g. gemmata*); and it is impossible to determine whether the thallus is that of *V. epidermidis* or other *Verrucaria*, or belongs to the plant now to be described. Intermixed with the apothecia of

* A genus not mentioned in BERKELEY's "British Fungology" (1860).
† *Vide* Paper on "Parasitic Micro-Lichens" (*antea citat.*).

V. epidermidis are certain other perithecia—scattered, round, minute, punctiform—somewhat prominent. Instead of paraphyses of ordinary character, the parasite possesses long, delicate, branching filaments, like those of many lichen-spermogonia. Asci are frequently grouped and ribbon-shaped; giving a faint *blue reaction with iodine;* 8-spored. Sporidia ellipsoid, colourless, 1-septate, exactly like those of *Verrucaria gemmata*. The same hymenium, which contains sporidiiferous asci and ramose paraphyses, contains also stylospores, oval or ellipsoid, ·00066″ long; borne on long filiform basidia, resembling paraphyses; sometimes 1-septate; occasionally exhibiting 3 nuclei, central largest.

2. Associated with *Physcia obscura*, Fr., var. *leprosa*, Hepp; Morchone, Braemar; corticolous; Aug. 1856, W. L. L. (Mem. Spermog. p. 247.)—Black and punctiform, but exhibiting no reproductive structure.

3. Associated with *Lecidea ferruginea*, Huds., var. *sinapisperma*, DC.; on dead mosses, grasses, twigs of shrubs, &c.; Hepp Exsic. No. 200 (sub-nom. *Placodium sinapispermum*, DC.)—Scattered over the decayed vegetation on which the apothecia of the *Lecidea* occur, and apparently partly intermixed with them, are very minute, black specks, which are perithecia, containing brown, 3-septate, ellipsoid, largish sporidia or spores.

4. On thallus of *Lecanora polytropa*, Ehrh., var. *intricata*, Schrad., Penmanshiel, Berwickshire; Hardy, Novem. 1856; saxicolous.—Parasite occurs on thalline areolæ as punctiform and black conceptacles, very minute, sometimes papillæform and Verrucarioid, varying in size; full of corpuscles, which may be either sporidia or stylospores (for neither asci nor basidia were observed), these reproductive corpuscles being very variable in size and shape—spherical to figure-8-shaped, simple to 1-septate, and colourless. The parasite is certainly not the *Thelidium epipolytropum* of Mudd (Brit. Lich. p. 298). I have also met with what appears to be the latter, externally resembling Verrucarioid spermogonia, and containing ellipsoid, 1-septate sporidia, with pale yellow loculi, but having no distinct paraphyses; while Mudd describes the paraphyses as distinct in his plant.

5. On apothecia (disk) of *Physcia chrysophthalma*, L., var. *Dickieana*, Linds. (Nyl. and Mudd, Brit. Lich. p. 112; sub-nom. var. of *Physcia villosa*, Dub., in Linds. Mem. Spermog., plate xiii. fig. 14); Belfast, Prof. Dickie.—Parasite consists of small, round, brown, quite superficial papillæ or points, easily removable. Its envelope is composed of dark brown or bluish-brown cellular tissue, but the conceptacle contains no sporidia, stylospores, nor spermatia.

6. On thallus of *Lecidea albo-atra*, Fr.; shore of Great Island, Cork, Carroll; Sept. 1858.—Parasite is studded over areolate thallus as black papillæ, generally crowded; varying in size; frequently flattened and irregular in form; semi-immersed; sometimes confluent, and then very difform.

7. With *Verrucaria fusiformis*, Leight.; Douglas, near Cork; on ash; Carroll,

Mar. 1858.—Perithecia are black and punctiform, containing in great numbers corpuscles that are ·00025″ long, and ·000066″ broad; simple, or sometimes faintly 1-septate, brown, linear or ellipsoid-oblong, frequently somewhat constricted centrally. Neither asci nor basidia were visible, and the corpuscles above described may therefore be either sporidia or stylospores.

8. The horizontal squamules (and, to a less extent, the scales of the podetia from base to apex) of a specimen of *Cladonia bellidiflora*, Ach., collected on Kelly's Green, Ireland, by Dr Moore, Aug. 1853, in Herb. Carroll, (Linds. Mem. Spermog. p. 163), bear, copiously scattered, a parasite, which has certain of the characters of Nylander's *Lecidea Cladoniaria** (Enum. Génér., Suppl. p. 339). His description, however, is imperfect, *e.g.*, as regards the sporidia, which, he hints, may sometimes be normally *brown*. In the Irish plant, the sporidia are eight in each ascus, arranged in one series; ellipsoid, simple, and colourless, ·00033″ long, ·000111″ broad; asci elongated, ·00166″ long, ·00033″ broad; paraphyses with discrete tips, but colourless, and not thickened. With apothecia, having externally the characters partly of those of *Abrothallus Smithii*, partly of *A. oxysporus*, are associated *Pycnidia*, containing stylospores precisely of the characters of the sporidia as respects size, form, colour, and structure, ·00033″ long, ·00014″ broad. Externally, however, these pycnidia are always brown. In my "Memoir on Spermogones and Pycnides," I have described them as *spermogones;* but their contained corpuscles have rather the characters of *stylospores*.† The apothecia have a convex surface in maturity; seldom sessile, and equally seldom altogether immersed; the body or bulk being generally immersed, and the surface nearly on the same level as the thallus of the host. They are discoid; black throughout; and their section resembles that of a double convex lens. In the young state they appear as minute, black papillæ, emergent from the thallus; in which condition they are apt to be confounded with the pycnidia.

In my "Memoir on Spermogones," I have mentioned this parasite under the head of Nylander's *Lecidea Cladoniaria;* to which I have also provisionally referred a commoner parasite on *Cladonia uncialis*, Hffm. (p. 285, plate vii. figs. 14–16). But the stylospores of the latter parasite are not the same as those of the parasite on *C. bellidiflora;* and, indeed, the two parasites seem distinct in several essential respects. Nor does Nylander mention either spermogonia or pycnidia as possessed by his plant. While, then, it is possible that one or other of the parasites in question is referable to Nylander's plant, it is equally likely they are hitherto undescribed. Should this prove to be the case, I propose for that which affects

* It may also be compared with his *Lecidea oxysporella* (Prod. 145), which grows on the thallus of *C. digitata* on the Splügen; and with *Lecidea Cetraricola*, Linds. ("Lichenicolous Micro-Lichens," Quart. Journal of Microscopical Science, Jan. 1869).

† I have pointed out the anatomical or morphological distinction between *stylospores* and *spermatia* in my paper on "Polymorphism in the Fructification of Lichens" (*antea citat.*).

C. bellidiflora—as an appropriate name—*Abrothallus Moorei*,* in honour of the distinguished Director of the Botanic Garden of Glasnevin, Dublin, who has made so many important contributions to the Irish flora—cryptogamic as well as phænogamic.

The protothallus of various *Cladoniæ* is affected by *Nesolechia punctum*, Mass. (Körber, Parerga, p. 461), the sporidia of which are minute, linear-fusiform, simple, and hyaline.

9. On thallus of *Squamaria crassa*, Huds.; Crosshaven, Cork Harbour, Sullivan. Parasite occurs as deep bluish-black round maculæ, surrounded frequently by a black ring; both conspicuous on the buff-coloured thallus of the host; seated on a sort of thalline papillæ; body immersed. Paraphyses Verrucarioid—very delicate, wavy, filiform, indistinct—not knobbed nor coloured at tips; asci ·0028″ long, and ·00066″ broad. Sporidia brown, soleaform, ·00050″ to ·00066″ long, ·00025″ broad; while in the asci always have the broadest and shortest end upwards.

This parasite is obviously different from the *Sphæria squamarioides* and *S. gelidaria* of Mudd. (Brit. Lich. p. 130), which affect the thallus of *Squamaria gelida*, L.

Nor does it appear to be any of these parasites which copiously affects the apothecia of *S. saxicola*, Poll., in a specimen which I collected near Jerkin, Norway (4600 feet), in August 1857. I have not in this case, however, been able to detect reproductive structure. In its young state the parasite appears as black spots on the epithecium. These gradually increase in number, and at length coalesce till they cover the whole disk; which covering leads apparently to the degeneration and consequent shrivelling of the whole apothecium. Its outline becomes most irregular; both exciple and disk acquire a very black granular surface, while the whole apothecium decreases in thickness. At a later stage it appears as a very black shapeless granular mass, frequently crowded or confluent, conspicuous on the pale stramineous thallus.

Nylander (Scand. p. 133), describes a parasitic *Sphæria* as affecting, in some parts of Scandinavia, *Squamaria saxicola* and *S. chrysoleuca*, Sm. It is black, punctiform, immersed in the thallus; spores fusiform, colourless; possessed of spermogonia, which are also black and punctiform, containing minute straight spermatia.

Körber (Parerga, p. 458) describes *Conida clemens*, Tul. (Mém. p. 124, sub *Phacopsis*) as parasitic on the apothecia of *Squamaria chrysoleuca* and *saxicola*; the sporidia being small, irregularly oblong, 1-septate, and hyaline. Also *Cercidospora Ulothii* (Parerga, p. 466), as affecting the thallus of *S. saxicola*; sporidia fusiform or cymbiform, 1-septate, and hyaline. *S. saxicola* is also affected with *Lecidea micraspis*, Smrf., and *Thelidium epipolytropum*, Mudd.†

* In my MS. Notes on Moore's Irish Lichens—made in 1858—I named this parasite provisionally *Abroth. Cladoniarum*, but any such specific designation is apt to lead to confusion with Nylander's *Lecidea Cladoniaria*.

† *Vide* Paper on "Parasitic Micro-Lichens" (*antea citat.*).

10. On or with *Lecanora varia*, Ach., var. *symmicta*, Ach.; on rotten stumps of *Pinus sylvestris*, Blaeberry Hill, Perth, April 1858, W. L. L. Conceptacles, externally resembling spermogonia, contain deep brown, oval or ellipsoid, apparently simple, sporidia, ·0005″ long, ·00033″ broad.

11. On *Lecidea rupestris*, Scop. (sub-nom. *Biatora rupestris*, var. *calva*, Dicks.), on limestone rocks, in HEPP's Exsic. No. 134. Parasite consists of very small, black, punctiform perithecia, scattered among the apothecia of the *Lecidea*, externally resembling spermogonia, but containing very deep brown, oval sporidia; simple, or 1-septate, or both; the colour rendering it impossible to determine their structure. NYLANDER arranges *L. rupestris* as a variety under *Lecanora cerina*; a classification to which I cannot subscribe.

12. Accompanying *Pyrenothea verrucosa;* on old oak, Castle Bernard, near Cork, Carroll. Parasite is seated on some of the thalline verrucæ, associated and apt to be confounded with spermogonia; sporidia spherical, brown, ·00025″ in diameter.

13. On thallus of *Endocarpon microsticticum*, Leight. (which appears to be only a var. of *Lecanora cervina*, Pers.; having quite the aspect of the common var. *smaragdula*, Whlnb.); Barmouth, North Wales, Leighton, 1856. Hymenium gives no blue with iodine. Asci sublinear, ·00020″ to ·000233″ long, ·00033″ to ·0005″ broad. Sporidia deep brown or olive according to age, 1-septate, oval, ·0005″ long, ·00025″ broad, arranged either in a single row, or in a double series, in each ascus.

Endocarpon rufescens, Ach. is the seat of *Sphæria Hookeri*, Nyl. (Prod. p. 139 and 175; LINDS. Otago Lich. and Fungi, p. 438), which has broadly fusiform, 3-septate sporidia (NYL. Prod. 139), becoming sometimes 5-septate or polyseptate and muriform (MUDD, Brit. Lich. p. 271, plate v. fig. 112), in all cases brown —sometimes constricted centrally or opposite each septum.

Lecidea Endocarpicola. On the thallus of *Endocarpon hepaticum*, Ach.—on walls, Lower Glanmire Road, Cork, Carroll—there is a parasitic *Lecidea* associated with the apothecia and spermogonia of the *Endocarpon*, having many of the characters of *L. aromatica*, Turn. (which, however, is not known to occur in the athalline condition). The paraphyses have deep brown or bluish-black apices, which are irregularly knobbed; their bodies constitute, however, a mere striated indistinct mass. Hymenial gelatine and asci become deep indigo-blue under iodine; latter are ·00233″ long, and ·00050″ broad. Sporidia very variable in size, length from ·00033″ to ·00083″, and in breadth from ·000083″ to ·000133″; ellipsoid-oblong or linear-oblong; simple in young state, normally 3-septate in maturity.

14. On thallus of *Usnea barbata*, Fr., var. *florida*, L.; Rio Janeiro, Henry Paul, 1851. Parasite is seated on some of the thalline tubercles usually occupied by the spermogonia. Sporidia brown, 1-septate; very different from the simple, colour-

less, oval sporidia of the *Usnea*. No hymenial tissue, asci, nor paraphyses can be made out, even under iodine; which, however, produces in some places only a *blue reaction in the medullary tissue* of the *Usnea*. The structure of the spermogones of the *Usnea* is described and figured in my "Memoir on Spermogones" (p. 122, plate iv. figs. 2–5). This parasite has certain points of resemblance, especially as regards the sporidia, to *Phymatopsis dubia*, Linds., and *Abrothallus Usneæ*, Rabenh., as I have described and figured them in my "Otago Lichens and Fungi" (p. 442, *et seq.*, plate xxx. figs. 36–41).

15. On sterile thallus of *Parmelia perlata*, L.; India, M. C. Cooke, 1866; ordinary a-ciliate form of the *Parmelia* as it occurs, from Britain, Norway, New Zealand, and the Canary Islands, in my Herbarium. In what appears to be its highest stage of growth, the parasite occurs as sub-rotund or sub-difform, raised, sub-convex, black maculæ, with a granulate irregular surface. In the young state it is developed as punctiform or papillæform bodies, sometimes girt with a ragged thalline margin. In the young state the body is wholly immersed in the thallus of the host or nearly so, while in age it emerges and becomes epithalline. In none of its stages of growth does the parasite show sporidia or other reproductive structure.

16. Associated with *Verrucaria Taylori*, Carr., and *Opegrapha vulgata*, Ach.; corticolous; Dunscombes Wood, Cork, Carroll. Perithecia contain sporidia that are brown, 3-septate, bulging opposite each septum; ·00083″ long, and ·00033″ broad.

17. On thallus of *Lecidea Hookeri*, Schær. (sub-nom. *L. spherica*, Schær.) in his Exsic. No. 526. The thalline squamules are dotted over with small, black, prominent papillæ, externally resembling spermogonia, but containing sac-shaped asci, and 1-septate, colourless, ellipsoid sporidia, somewhat resembling those of some forms of *Verrucaria epidermidis*. The same thallus bears the parasitic *Sphæria Hookeri*, Nyl. (Prod. 175 and 139; Linds. "Otago Lich. and Fungi," p. 438)* with verrucarioid perithecia, and deep brown, 3-septate sporidia, ·001″

* Two specimens of *S. Hookeri* (sub-nom. *Verrucaria*), which I examined in the Kew Herbarium, had the following characters:—

1. Summit of Ben Lawers. Thallus Parmelioid, pale yellowish-white. Perithecia are quit those of a *Verrucaria;* seldom, however, forming regular cones or papillæ; more usually flattened and irregular as to form and size. None of the hymenial elements give blue with iodine. Sporidia broadly ellipsoid, tapering suddenly at the tips; 3-septate; becoming by longitudinal sub-division of the loculi sub-muriform; deep brown; ·001″ long, ·0005″ broad.

2. Gemmi, Switzerland. Perithecia much larger and ostioles more distinct; immersed or semi-immersed; bursting through the cortical layer of thallus, with—at least usually at first, in their young state—stellate fissuring. Thallus here again Parmelioid and simple; usually buff-coloured, sometimes pale green. The plant has an Endocarpoid facies.

In both cases the perithecia occur by themselves on a thallus, which appears to belong to them. It seems to me that it is the same plant that occurs sometimes with a proper thallus (*Verrucaria*), and at other times as an athalline parasite (*Sphæria*); that it has equal claims to rank as a *Sphæria* or *Verrucaria;* and that it matters little whether it is classed among the *Sphæriæ* or *Verrucariæ*—*fungi* or *lichens*—provided only fungologists and lichenologists would come to some common understanding regarding it!

long, and ·0004″ broad. The *Lecidea* itself (in my copy, original edition, 1847) has simple, ellipsoid, colourless sporidia; while those of the true *L. Hookeri*, according to NYLANDER (Prod. p. 139), are brown and 1-septate.

18. On thallus of *Lecidea sanguinaria*, Ach., var. *affinis*, Schær. (Exsic. No. 629, on left hand specimen in my copy, orig. ed. 1852). Intermixed with the spermogonia, and indistinguishable therefrom; but the parasitic perithecia contain round, brown spores.

19. On thalline scales of *Lecanora coarctata*, Ach., var. *involuta*, Tayl. (sub-nom. *L. involuta*, Tayl., Fl. Hibern., p. 134); Dunkerron, Taylor in Herb. Moore.; on grey sandstone; associated with *L. varia*. Parasite occurs as minute black cones, externally resembling spermogonia, but exhibiting no reproductive structure.

20. On thallus of an isidioid form of *Lecanora parella*, Ach. (sub-nom. *Lichen dactylinus*, Ach.), collected by Dr SCOTT, 1802; in Herb. Kew, where it was examined by DAWSON TURNER. Associated with spermogonia, and externally resembling them. Parasite is black and discoid; immersed, and bursting through cortical layer of thallus of host.

21. On thallus of *Verrucaria Garovaglii*, Mont. (sub-nom. *Thelotrema Schæreri*) Hepp, Exsic. No. 100; which I regard as a mere form of *V. pallida*, Ach. Parasite may be externally confounded either with the sporidiiferous perithecia or spermogonia of the *Verrucaria;* but its sporidia are oblong-ovoid, colourless, and 1-septate.

22. On thallus of *Graphis scripta*, Ach., var. *horizontalis*, Leight. Exsic. No. 244 (sub-nom. *G. serpentina*, var.); Abdon, Shropshire. Intermixed with apothecia and pycnidia, and externally resembling the latter; occurring here and there as minute black cones, full of minute brown spherical sporidia.

23. Associated with *Opegrapha atra*, Pers., var., and *Lecidea canescens*. Aghada; corticolous; Carroll. Possesses no distinct paraphyses. Sporidia simple, pale brown, ·00066″ long, ·00033″ broad—contained in asci.

24. Associated with *Lecanora pyracea*, Ach. (sub-nom. *Biatora rupestris*, var. *irrubata*) in Leighton's Exsic. No. 213, are conceptacles externally resembling pycnidia or spermogonia, which contain not only stylospores but sporidiiferous asci; in which, further, the stylospores and sporidia have the same characters. The perithecia occur as small, brown, punctiform bodies seated on the thalline scales of the *Lecanora*. Stylospores are oblong-ellipsoid—normally 1-septate; granular or occupied by two or more nuclear globules or cellules in the young and older states; borne on long, filiform basidia. Sporidia also 1-septate, and having otherwise precisely the characters of the stylospores; asci 8-spored. There is no possibility of confounding the internal structure of what appears to be a *fungus* with that of the ordinary spermogonia of the *Lecanora*, which possess arthrosterigmata, and very short rod-shaped spermatia. The existence in this fungus of stylospores and sporidia within the same perithecium—springing from the same

hymenium—is most interesting in both an anatomical and physiological point of view. I have met with the same phenomenon in several other fungi, *e.g.*, that described in this paper as associated with *Verrucaria epidermidis*. Parallel phenomena are the co-existence of sporidia and spermatia or stylospores in the same perithecia in *Sphæria Lindsayana*, Curr. (LINDS. "Otago Lich. and Fungi," p. 425, plate xxx. fig. 7); of sporidia and spermatia in *Verrucaria atomaria*, Ach. (LINDS. "On Polymorphism in the Fructification of Lichens," in Quart. Journal of Microscopical Science, Jan. 1868); and of spermatia in the ordinary sporidiiferous perithecia of *Verrucaria*, by GIBELLI (Annals of Nat. History, April 1866, p. 270).

25. Associated with *Lecidea lurida*, Ach., in Herb. Kew; "sea rocks near Bangor, July 1802." Thallus exhibits a number of spermogonia scattered about the margins of its lobes as deep brown points, the body of the conceptacle being immersed in the thallus. Intermixed are the externally similar, but more conoid, perithecia of the parasite, whose hymenium gives no blue with iodine. Asci apparently polysporous; ·0020″ long, ·00066″ broad. Sporidia fusiform or ellipsoid, dark bottle-green or brown, irregularly 3-septate in maturity; ·0005″ to ·00066″ long, ·00014″ broad.

On the same sheet, and associated with *L. lurida*, are fastened specimens of what appears to be the same lichen, labelled "No. 19, on rocks by the sea, Miss Hutchins," from Ireland doubtless. In both, the apothecia are distinctly Lecanorine in the young state, possessing a thalline margin, and thus differing altogether from the *Lecidea*. But their apothecia resemble those of *L. lurida* in the old state, when the disk becomes sub-convex, and the thalline border disappears, or is covered by the swollen disk. The disk in the Lecanorine apothecia is usually of a lighter red than in *L. lurida*. In Miss HUTCHINS' plant the thallus is much paler than in Bangor specimens. The colour of the thallus obviously varies, just as it does in *Physcia aquila*, with its degree of exposure to light; being palest when the plant grows in the shaded crevices of rocks. In the Irish plant the paryphyses are subdiscrete, with brown tips; the asci 8-spored, ·00166″ long, ·0005″ broad; the sporidia ellipsoid, colourless, apparently 1-septate, ·00033″ long, 00014″ broad. Probably the lichen in both the Bangor and Irish specimens is *Lecidea sublurida*, Nyl. (MUDD. Brit. Lich. p. 172), which MUDD places in the genus *Thalloidima*, Mass.

26. *Several* parasitic fungi, or fungoid growths of the most diverse character, affect the apothecia of *Abrothallus Smithii*, Tul., or are associated with its pycnidia. But their apparent frequency in that lichen probably depends simply on the greater amount of attention I gave to the examination of the pseudogenus *Abrothallus* while preparing my "Monograph" thereof* in 1856.

* Quarterly Journal of Microscopical Science, vol. v. 1857.

(*a*) Ben Lawers. Intermixed with the pycnidia of the *Abrothallus*, and externally indistinguishable therefrom, is a minute papillæform parasite, which consists of an envelope of dark-brown, hexagonal, cellular tissue, enclosing myriads of dark-brown spherical spores, which are frequently irregular or jagged in outline, like blood-corpuscles in a condition of shrivelling from exosmosis.

(*b*) Var. *Welwitzschii*, Tul.; Amulree Road, Dunkeld. Black perithecia—externally resembling pycnidia, with which they are associated—contain nothing but spherical oil globules, or corpuscles closely resembling them.

(*c*) Craigie Hill, Perth As in (*a*) and (*b*), intermixed with pycnidia, and like them papillæform or punctiform. They contain—

1. Largish, spherical corpuscles, with pale brownish-yellow subgranular protoplasm, resembling the sporidia of certain lichens, *e.g.* some forms of *Lecanora cinerea*. Sometimes the protoplasm becomes distinctly circumscribed and separated from the cell-wall by a varying hyaline interspace. This protoplasm gradually acquires a nuclear character and a central position, and then divides into two or four (sometimes three) equal subspherical segments, after the manner of some of the larger forms of gonidia. In age, both cell-wall and outline of nucleus, or its segments, become irregular, as if from shrivelling.

2. Corpuscles resembling shrivelled sporidia; most irregular in form, colourless, generally with double contour, and containing one or more largish, distinct subspherical nuclei, and frequently also fine granular protoplasm. These corpuscles are often found attached to each other in groups of two or more.

3. Most irregular, ribbon-like tubules, marked by subspherical nuclei, which are sometimes of an iodine colour. In some cases these would appear to be mere chains of degenerate sporidia. Sometimes only two or three constitute the pseudo-tubule, whose septa (the walls of the sporidia) have disappeared. But at other times the outline of the sporidia remains; there is a pedicle formed by the base of the shrivelled ascus; the nuclei are polar and distinct, sometimes yellowish; or they are connected by a central canal, as in the sporidia of *Physcia parietina*.

A solitary black conceptacle, externally resembling an apothecium of the *Abrothallus*, picked off the bluish, curled squamules of the host (*Parmelia saxatilis*), consists of an envelope of dark-brown, honeycomb-like cellular tissue; rootlets being sent downwards into the tissues of the thallus of the *Parmelia*, penetrating through its cortical and gonidic layers to the medullary tissue. It contains—(1.) A parenchyma of colourless hexagonal cells, associated with mycelioid tubes—also hyaline, but short and thickish, and intermixed with much oily matter in the form of globules; (2.) Largish, spherical, colourless, sporoid corpuscles, full of a nucleiform, cellular, or granular protoplasm.

On one of the true apothecia of *A. Smithii*, from Craigie, I found a large, dark-brown, 3-septate sporidium, with bulgings opposite the loculi. Its size and form

are so different from those of the sporidia of the *Abrothallus* (as figured in my "Monograph," pl. iv.) that it is more probably referable to some *Sphæria* or fungus—not necessarily immediately associated with the *Abrothallus*, for in the course of microscopic studies on lichens, I have frequently met with *alien* sporidia—sporidia belonging to other and topographically distant lichens or fungi. Thus, in a specimen of var. *Welwitzschii* in LEIGHTON's Exsic. No. 191, I found a number of dark-brown figure-8-shaped sporidia on and among the thalline rhizinæ of *Parmelia saxatilis*. They had not the usual soleaform character of the sporidia of *A. Smithii* and its varieties; nevertheless they probably belonged, in this case, to the parasitic *Abrothallus*.

(*d*) Var. *Welwitzschii* (LEIGHTON's Exsic. No. 191). A specimen of the deformed thallus of *P. saxatilis*, without apothecia of the *Abrothallus*, bears bodies externally similar—like some degenerate forms of the apothecia of *A. Smithii*. Their envelope is of hexagonal cellular tissue, containing bodies like some forms of gonidia in process of segmentation—large spherical cells with delicate hyaline wall, enclosing centrally four bluish corpuscles, evidently resulting from segmentation into four of a central spherical nucleus.

(*e*) A specimen of *A. Smithii* (from Glen Dee, Braemar; on boulders, August 1856, W. L. L.), bears a Sphærioid parasite on its *apothecia*. In another specimen of the same *Abrothallus*, from Glenbeg, between Spittal of Glenshee and Braemar (on a roadside wall), August 1856, a similar parasite, occurring on the thallus of *P. saxatilis*, resembles externally the apothecia of the *Abrothallus*, and is apt to be confounded therewith. It contains a mass of minute globular brown spores, intermixed with a few partially disintegrated sporidia of the *Abrothallus*.

(*f*) Associated with *A. oxysporus*, Tul., and with the pycnidia of *A. Smithii* (on an old wall, top of Craig-y-Barns, Dunkeld, June 1856, W. L. L.), on thallus of *P. saxatilis*. Parasite punctiform, black, containing masses of hyaline Toruloid spore-filaments, with myriads of very minute, also colourless, globular cells, generally aggregated in irregular masses; associated with a few sporidia, partially degenerate, both of *A. oxysporus* and *A. Smithii*.

Those parasitic fungi, accompanying *Abrothallus Smithii*, that are Verrucarioid externally, are apt to be confounded not only with the *pycnidia* of the *Abrothallus*, but with young states of the *apothecia* of both *A. Smithii* and *A. oxysporus*.

27. In my copy of SCHÆRER's Exsic. No 503, *Calicium disseminatum*, Fr., *pàtellæforme*, Sch., has not the sporidia of the *Calicium*, which are, according to NYLANDER (Syn. 146), blackish, oblong, and sometimes subspherical; but ellipsoid, colourless ones, ·00033″ long, 00013″ broad, contained in asci ·00133″ long, ·00033″ broad. There are no distinct paraphyses, and the plant may be regarded as either *Verrucaria* or *Microthelia*—*lichen* or *fungus*.

EXPLANATION OF PLATES XXIII., XXIV.

Plate XXIII.

Figs. 1 to 18. *Torula lichenicola.*

1 to 12. On *Lecanora subfusca.*

1. Craig Choinich, Braemar.
   (*a*) Portion of thallus, with apothecia, of the *Lecanora.*
   (*b*) Sections of said thallus and apothecia—magnified.
   (*c*) One of its apothecia—magnified.
   (*d*) Spore-filaments and spores of *Torula.**
2. Ben Lawers. Spore-filaments and spores of *Torula.*
3. Loch Tay. Do.
4. Kyles of Bute. Do.
5. Caerlaverock road, Dumfries. Spores.
6. Dunglass, Berwickshire. Spore-filaments and spores.
7. Pease Dean, Berwickshire. Spores.
8. Near Cork.
   (*a*) Portion of thallus of the *Lecanora* with apothecia.
   (*b*) Section of said thallus and apothecia.
   (*c*) Spore-filaments and spores of *Torula.*
9. Castle Bernard, Co. Cork. Spore-filaments and spores.
10. Rathconnac, Co. Cork.
    (*a*) Portion of thallus, with apothecia, of the *Lecanora.*
    (*b*) Section of said thallus and an apothecium.
11. Great Island, Cork.
    (*a*) Portion of thallus of the *Lecanora* with apothecia.
    (*b*) Spores.
12. Carrigaloe, Cork.
    (*a*) Portion of thallus of *Lecanora.*
    (*b*) Section of do.
13. On *Lecidea canescens.* Aghada, Cork.
    (*a*) Portion of thallus of the *Lecidea* with apothecia.
    (*b c*) Sections of said thallus and an apothecium.
14. On *Lecidea parasema.* Ireland. Spore-filaments and spores of the *Torula.*
15. Accompanying *Opegrapha atra*, Schærer's Exsic. No. 634. Spore-filaments and spores.
16. Accompanying *Verrucaria epidermidis*, var.; Malham, Yorkshire. Spore-filaments and spores.
17. In spermogonia of *Lecanora varia*, Leighton's Exsic. No. 176.
    (*a*) Portion of thalline scales bearing spermogonia.
    (*b*) Section of said spermogonia.
    (*c*) Normal spermatia and sterigmata of the *Lecanora.*
    (*d*) Associated *Torula.*
    (*e*) Spore-filaments and spores of do.
18. *Torula lichenicola* on *Lecanora subfusca.* Ardrum, Co. Cork. Spore-filaments and spores.

Fig. 19. *Coniothecium lichenicolum.* On *Lecanora parella.* Morchone, Braemar.
   (*a*) Portion of thallus of *Lecanora*, showing the parasite on its areolæ.
   (*b*) The *Coniothecium*, magnified and sectioned.

Fig. 20. *Isidium corallinum.* Craigie, Perth.
   (*a*) Section, logitudinal.
   (*b*) Portions (terminal) of some of the Isidia, variously magnified.
   (*c*) Portion of the plant viewed from above, showing the brown-tipped apices of the Isidia.

Fig. 21. Parasite on *I. corallinum* (sub-nom. *Lichen dactylinus*, Ach.), in Herb. Kew.
   (*a*) Section of disk.
   (*b*) Sporidia.

Figs. 22 to 28. *Coniothecium lichenicolum.*

22. On *I. corallinum.* Craigie, Perth.
    (*a*) Portion of thallus of the *Isidium.*
    (*b*) Do. magnified.
    (*c*) Sections of parasite.
23. *Diplotomma calcareum.* Clapham, Yorkshire.
    (*a*) Portion of thallus of the *Diplotomma.*
    (*b*) Do. magnified.
    (*c*) Sections of the parasite.
24. *Coniothecium lichenicolum.* Kinnoull, Perth. Spores.
25. Do. Scuir-na-gillean, Skye. Spores.
26. Do. Sligachan, Skye. Spores.
27. Do. Mangerton, Co. Kerry.
    (*a*) Portion of thallus of host.
    (*b*) Sections of the parasite, variously magnified.
    (*c*) Spores.
28. Do. North Wales; Davies, in Herb. Kew.
    (*a*) Sections of the parasite.
    (*b*) Spores.

* The magnifying power is that which I have uniformly adopted in my drawings of microscopical structure in Lichens, viz., 425 diameters linear (under Objective No. 3, and Eye-piece No. 3) of a Nachet's microscope made for me in 1851 (*vide* "Otago Lich. and Fungi," foot note, p. 410).

Fig. 29. *Microthelia Cookei*, on *Lecanora crenulata*. Chichester.
(*a*) Section of hymenium, showing asci and paraphyses.
(*b*) Sporidia.

Fig. 30. *M. Stereocaulicola*, on *Stereocaulon paschale*. Glen Derrie, Braemar.
(*a*) Portions of the podetia of *Stereocaulon paschale*, showing the deformities occupied by the parasite; variously magnified.
(*b*) One of the conglomerate wartlets isolated.
(*c*) Sections of the parasite.
(*d*) Ascus, with young sporidia.
(*e*) Mature sporidium.

Fig. 31. *M. Umbilicariæ*, on *Umbilicaria pustulata*. Norway.
(*a*) Portion of thallus of the *Umbilicaria*, magnified.
(*b*) Sections of the parasite.
(*Vide* also Plate xxiv. fig. 3.)

Fig. 32. *M. rugulosaria*, on *Placodium rugulosum*. Tasmania. Sporidia.

Fig. 33. *M. parietinaria*, on *Physcia parietina*. Cottishall. Sporidia.

Fig. 34. Parasite on *Thelotrema lepadinum*. Ireland.
(*a*) Sporidium.
(*b*) Stylospores.

Fig. 35. Parasite on *Lecanora cenisea*. Ayton, Cleveland. Sporidia.

Plate XXIV.

Fig. 1. *Microthelia Nephromiaria*, on *Nephromium cellulosum*. Hermite Island.
(*a*) Old apothecium of the *Nephromium*; under side—bearing the parasite.
(*b*) Sections of the parasite.
(*c*) Section of hymenium, showing an ascus and paraphyses.
(*d*) Sporidium, mature.

Fig. 2. *M. Nephromiaria*, on *Neuropogon Taylori*. Kerguelen's Land.
(*a*) Ascus.
(*b*) Mature sporidia.

Fig. 3. *M. Umbilicariæ*. Norway.
(*a*) Section of hymenium, showing asci and paraphyses.
(*b*) Young, and (*c*) Mature, ascus.
(*d*) Oil globules.
(*e*) Reaction of iodine on hymenial gelatine.
(*f*) Mature sporidia.
(*Vide* Plate xxiii. fig. 31.)

Fig. 4. *M. Stictaria*, on *Sticta Freycinetii*. Campbell's Island.
(*a*) Ascus, showing reaction with iodine.
(*b*) Sporidia, mature and young.

Fig. 5. Parasite on *Lecidea pachycarpa*. Ireland. Sporidia, young and mature.

Fig. 6. *Microthelia Bæomycearia*, on *Bæomyces rufus*. Balthayock.
(*a*) Portion of thallus of the *Bæomyces*, showing—(1) its own young apothecia; and (2) the parasite.
(*b*) Portion of same thallus, further magnified, showing young apothecia.
(*c*) Sections of said apothecia.
(*d*) Sections of parasite.
(*e*) Sporidia.

Fig. 7. *M. atricola*, on *Lecanora atra*. Derriquin, Co. Kerry.
(*a*) Perithecia, magnified; one sectioned.
(*b*) Sporidia.

Fig. 8. Parasite on *Pertusaria*. Balthayock, Perth. Sporidia.

Fig. 9. *Gassicurtia silacea*. Fontainebleau, Nyl. Exsic. No. 150.
(*a*) Portion of thallus of *Lecanora atra*, showing the parasite on its areolæ.
(*b*) Two of said areolæ, further magnified.
(*c*) Sections of the said areolæ and of their parasite.
(*d*) Spores.

Fig. 10. *Microthelia vesicularia*, on *Lecidea vesicularis*. Switzerland. Sporida.

Fig. 11. *Spilomium Graphideorum*. Fontainebleau, Nyl. Exsic. No. 72.
(*a*) Portion of thallus of *Graphis*, bearing the parasite.
(*b*) Sections of the latter.
(*c*) Spores.

Fig. 12. Parasite on *Lecanora polytropa*, var. *intricata*. Penmanshiel.
(*a*) Portion of thallus of the *Lecanora*, with apothecia and the parasite.
(*b*) Sections of young apothecia.
(*c*) Sections of mature apothecium and of the parasite.
(*d*) Sporida or stylospores.

Fig. 13. Parasite on *Lecidea albo-atra*. Great Island, Cork.
(*a*) Portion of the thallus of the *Lecidea* with apothecia and the parasite.
(*b*) Sections of (1) said apothecia and (2) parasite.

Fig. 14. Parasite on *Squamaria crassa*. Crosshaven, Cork.
(*a*) Thallus bearing apothecia and the parasite.
(*b*) Section of an apothecium and of the parasite.
(*c*) Section of hymenium, showing ascus and paraphyses.
(*d*) Mature sporidia.

Fig. 15. Parasite on *Squamaria saxicola*. Jerkin, Norway.
(*a*) Portion of thallus bearing apothecia and the parasite.
(*b*) Sections of said apothecia and parasite.

Fig. 16. Parasite on *Endocarpon microsticticum*. Barmouth, N. Wales.
(*a*) Section of hymenium, showing asci and paraphyses.
(*b*) Mature sporidia.

Fig. 17. *Lecidea Endocarpicola*, on *Endocarpon hepaticum*. Glanmire Road, Cork.
(*a*) Ascus under iodine, with young sporidia.
(*b*) Paraphyses, isolated.
(*c*) Sporidia, mature and young.

Fig. 18. *Abrothallus Moorei*, on *Cladonia bellidiflora*, Ach. Kelly's Green, Ireland.
(*a*) Ascus.
(*b*) Mature sporidia.
(*c*) Stylospores.

Fig. 19. Associated with *Verrucaria Taylori*. Dunscombes Wood, Cork. Sporidium.

Fig. 20. Associated with *Verrucaria fusiformis*. Douglas, Cork. Sporidia.

Fig. 21. Associated with *Graphis scripta*. Leighton's Exsic. No. 244. Sporidia.

Fig. 22. *Microthelia Collemaria*, on *Collema muscicolum*, Ach. On walls, Ingleby, Cleveland, Yorkshire, Mudd, 1857. (Compare Parasite (*Sphæria* or *Microthelia*) on *C. melænum*, Ach., in Linds. "Otago Lich. and Fungi," p. 442; and "Mem. Spermog." p. 272.)
(*a*) Section of hymenium, showing an ascus and paraphyses; with the reaction of iodine on the hymenial gelatine.
(*b*) Mature sporidia.

Fig. 23. Parasite on *Usnea barbata*, var. *florida*. Rio Janeiro. Sporidia.

Fig. 24. Parasite on *Urceolaria*. Glenarm, Co. Antrim. Spores or stylospores.

Fig. 25. Associated with *Opegrapha atra*, Leighton's Exsic. No. 245. Sporidia.

Fig. 26. Associated with *Opegrapha atra*, Schærer's Exsic. No. 634. Ascus and sporidia.

Fig. 27. *Sphæria Hookeri*, on *Lecidea sphærica*. Schær. (Exsic. No. 526). Sporidia;
(*a*) One of them preparing to germinate.

Fig. 28. *S. Hookeri* (sub-nom. *Verrucaria*), in Herb. Kew.
(*a*) Specimen from the summit of Ben Lawers; perithecia magnified and sectioned.
(*b*) Specimen from the Gemmi, Switzerland; Sporidia.

Fig. 29. Accompanying *Endocarpon rufescens*, Ach. Schærer's Exsic. No. 465. Ascus with young sporidia. (Perhaps *Endocarpon cinereum*, Pers.?)

Fig. 30. Associated with *Physcia astroidea*, Fr., var. *Clementi*, Turn. Sporidia. (Perithecia verrucarioid.)

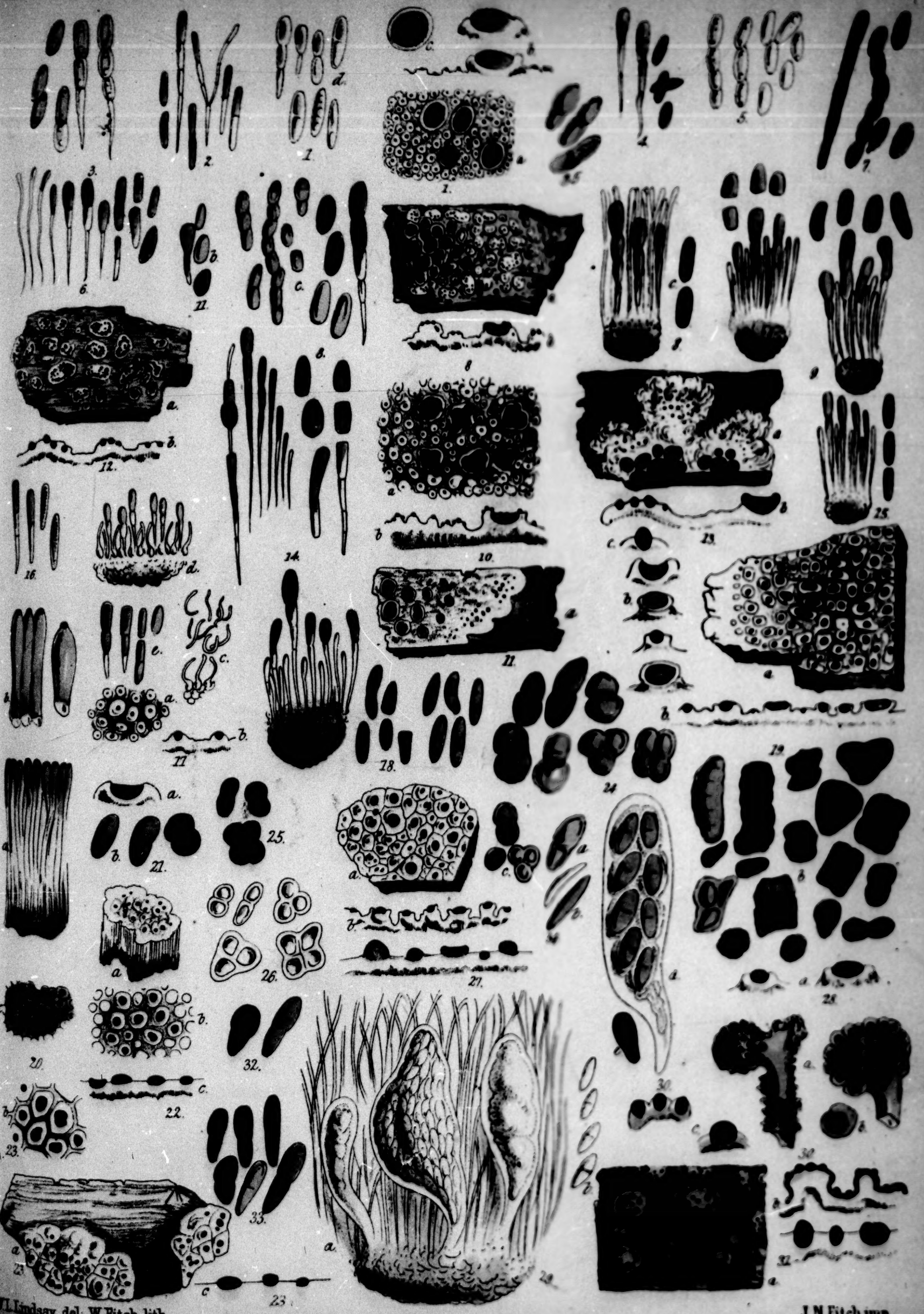
Fig. 31. Associated with *Umbilicaria hyperborea*, Hffm., Schærer's Exsic. No. 151. Sporidia.

Fig. 32. Parasite on *Lecidea sanguinaria*, var. *affinis*. Schær. Exsic. No. 629.
(*a*) Sporidium.
(*b*) Spores.

Fig. 33. Associated with *Abrothallus Smithii*, Tul. Craigie Hill, Perth.
(*a*) Perithecium of dark-brown hexagonien-chyma; parasitic on thallus of *Parmelia saxatilis*.
(*b*) Mycelium; (1) spores, and (2) oil globules.
(*c*) Spores.

Fig. 34. Associated with *Abrothallus oxysporus*, Tul. Craig-y-Barns, Dunkeld. Toruloid spore-filaments and spores.

Fig. 35. Associated with *Lecidea lurida*, Ach. In Herb. Kew. Sporidia.
(*a*) On seaside rocks, Ireland, Miss Hutchins.
(*b*) Seaside rocks, Bangor, July 1802.



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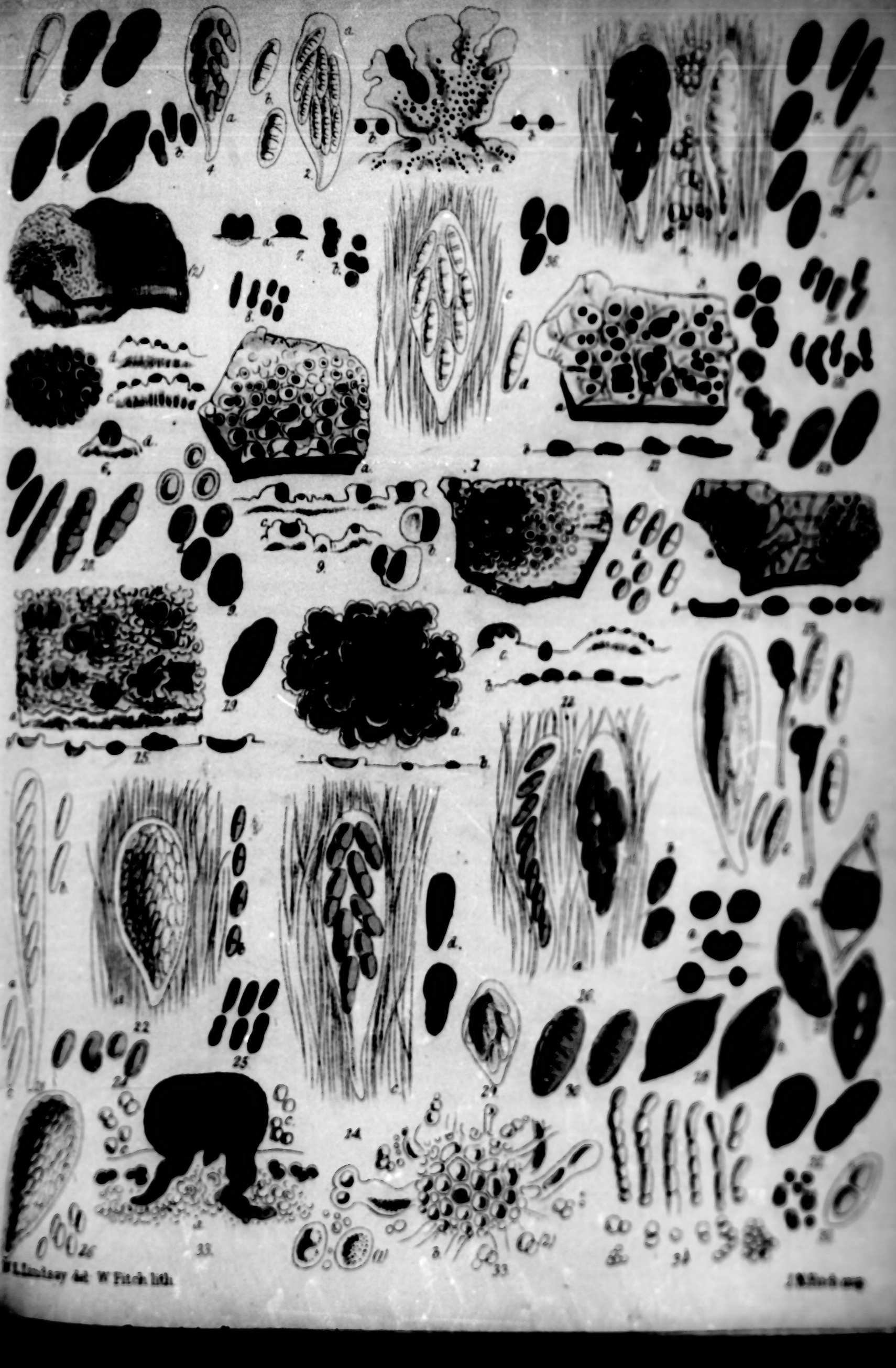
J. N. Fitch imp